



United States  
Department of  
Agriculture

Forest  
Service

Ashley National Forest

Supervisor's Office  
355 North Vernal Avenue  
Vernal, UT 84078

File Code: 2810

Date: November 29, 2001

m/13/02

Paul Baker  
Utah Department of Oil, Gas & Mining  
1594 West North Temple  
Salt Lake City, UT 84114

Dear Mr. Baker:

Enclosed is the Plan of Operations and additional information for Uintah Mountain Copper Company's proposal for the Paint Mine.

If you have questions please contact Chauncie Todd at (435) 781-5114 or [ctodd@us.fed.us](mailto:ctodd@us.fed.us).

Sincerely,

BERT KULESZA  
Forest Supervisor

Enclosures: 2

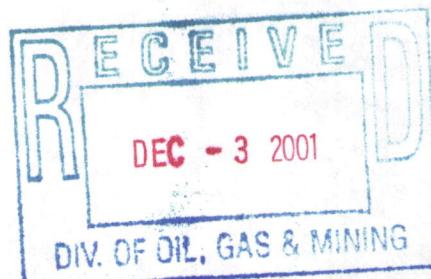
cc: Chauncie Todd

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DIVISION OF  
OIL, GAS AND MINING





## PLAN OF OPERATIONS FOR MINING ACTIVITIES ON NATIONAL FOREST SYSTEM LANDS

Submitted by:  President 8/23/01  
 Signature Title Date

Plan Received by: Chaurice H. Todd Forster 9/4/01  
 Signature Title Date

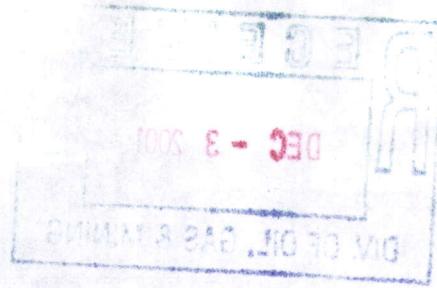
### **I. GENERAL INFORMATION**

- A. Name of Mine/Project: Sunshine Quartz/Hematite Claims Project
- B. Type of Operation: Exploration and development  
(lode, placer, mill, exploration, development, production, other)
- C. Is this a (new/continuing) operation? (circle one). If continuing a previous operation, this plan replaces/modifies/supplements a previous plan of operations. (circle one )
- D. Proposed start-up date of operation: August 1, 2001 (upon approval of EA)
- E. Expected total duration of this operation: 3 months
- F. If seasonal, expected date of annual reclamation/stabilization close out: n/a
- G. Expected date for completion of all required reclamation: October 31, 2001

### **II. PRINCIPALS**

- A. Name, address and phone number of operator: Uintah Mountain Copper Company  
P.O. Box 578  
Price, Utah 84501      435-820-6460
- B. Name, address, and phone number of authorized field representative (if other than the operator).  
 Attach authorization to act on behalf of operator.  
Same as above
- C. Name, address and phone number of owners of the claims (if different than the operator):  
Same as above

*(If more space is needed to fill out a block of information, use additional sheets and attach to form)*



- D. Name, address and phone number of any other lessees, assigns, agents, etc., and briefly describe their involvement with the operation, if applicable:  
None
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### **III. PROPERTY OR AREA**

Name of claim, if applicable, and the legal land description where the operation will be located.

MC#	Name	Section	Township	Range
320742	Sunshine Quartz Mine No. 43	NW1/4 Sec 15, SW1/4	Sec 10 T2N	R6W
320743	Sunshine Quartz Mine No. 4	NW1/4 Sec 15	T2N	R6W
320749	Hematite No. 5	NW1/4, NE1/4 Sec 15	T2N	R6W

### **IV. DESCRIPTION OF THE OPERATION**

- A. **Access.** Show on a map (USGS quadrangle map or a National Forest map, for example) the claim boundaries, if applicable, and all access needs such as roads and trails, on and off the claim. Specify which Forest Service roads will be used, where maintenance or reconstruction is proposed, and where new construction is necessary. For new construction, include construction specifications such as widths, grades, etc., location and size of culverts, describe maintenance plans, and the type and size of vehicles and equipment that will use the access routes.

See attached USGS quad Map 1 and detailed site Maps 2-5 for road, site and camp locations.

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Work requires use the existing Forest Service access road to claims, with no new road construction. UMCC will continue to perform annual maintenance on road at no cost to FS. Maintenance includes hand clearing of rocks and fallen trees to the road side and repair of minor washouts from winter snowmelt. Detailed description of equipment is provided in Section B of the Supplemental Description.

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- B. **Map, Sketch or Drawing.** Show location and layout of the area of operation. Identify any streams, creeks or springs if known. Show the size and kind of all surface disturbances such as trenches, pits, settling ponds, stream channels and run-off diversions, waste dumps, drill pads, timber disposal or clearance, etc. Include sizes, capacities, acreage, amounts, locations, materials involved, etc.

See site maps for development area location. A test pit 0.05 acre is to be excavated to a maximum depth of 21 feet and reclaimed. An estimated 650 cy of hematite ore within the test pit area will be removed and hauled from the forest. All the remaining overburden (about 2000 cy) will be incorporated into the reclamation, with no tailings or waste resulting after completion of work. A detailed discussion of the scope of work is provided in the Supplemental Discussion.

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*(If more space is needed to fill out a block of information, use additional sheets and attach to form.)*

- C. **Project Description.** Describe all aspects of the operation including mining, milling, and exploration methods, materials, equipment, workforce, construction and operation schedule, power requirements, how clearing will be accomplished, topsoil stockpile, waste rock placement, tailings disposal, proposed number of drillholes and depth, depth of proposed suction dredging, and how gravels will be replaced, etc. Calculate production rates of ore. Include justification and calculations for settling pond capacities, and the size of runoff diversion channels.

A Phase 3 test pit excavation and reclamation development program is proposed. This project is an extension of completed Phase 1 and 2 test pit/reclamation work to perform small-scale ore removal and reclamation projects for evaluating and documenting economics and restoration techniques of a larger project. A detailed description of all work is provided in the Supplemental Discussion.

(If more space is needed to fill out a block of information, use additional sheets and attach to form.)

- D. **Equipment and Vehicles.** Describe that which is proposed for use in your operation (Examples: drill, dozer, wash plant, mill, etc.). Include: sizes, capacity, frequency of use, etc.

Equipment for road maintenance and test pit activities is described in Section B of the Supplemental Discussion.

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- E. **Structures.** Include information about fixed or portable structures or facilities planned for the operation. Show locations on the map. Include such things as living quarters, storage sheds, mill buildings, thickener tanks, fuel storage, powder magazines, pipelines, water diversions, trailers, sanitation facilities including sewage disposal, etc. Include engineering design and geotechnical information for project facilities, justification and calculations for sizing of tanks, pipelines and water diversions, etc.

A temporary facility (no permanent structures) covering 1.26 acres will be located at the permitted camp site area (see Map 5). Detailed discussion is presented in Section F of the Supplemental Discussion.

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#### ***V. ENVIRONMENTAL PROTECTION MEASURES (SEE 36 CFR 228.8)***

- A. **Air Quality.** Describe measures proposed to minimize impacts on air quality such as obtaining a burning permit for slash disposal or dust abatement on roads.

No burning of vegetation will be permitted on the claims or the camp site. Depending upon precipitation, ambient road dust will be controlled by water truck spray application. Diluted application of Forest Service approved, non-toxic dust palliatives (such as Soil Seal, Soil Cement, etc.) may be used if conditions warrant. No other impacts to air quality are anticipated. A detailed discussion on dust control water is presented in Section H of the Supplemental Discussion.

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*(If more space is needed to fill out a block of information, use additional sheets and attach to form. )*

B. **Water Quality.** State how applicable state and federal water quality standards will be met. Describe measures or management practices to be used to minimize water quality impacts and meet applicable standards.

1. State whether water is to be used in the operation, and describe the quantity, source, methods and design of diversions, storage, use, disposal, and treatment facilities. Include assumptions for sizing water conveyance or storage facilities
2. Describe methods to control erosion and surface water runoff from all disturbed areas, including waste and tailings dumps.
3. Describe proposed surface water and groundwater quality monitoring, if required, to demonstrate compliance with federal or state water quality standards.
4. Describe the measures to be used to minimize potential water quality impacts during seasonal closures, or for a temporary cessation of operations.
5. If land application is proposed for waste water disposal, the location and operation of the land application system must be described. Also describe how vegetation, soil, and surface and groundwater quality will be protected if land application is used.

No water is needed for test pit sample removal. Water for dust control will be obtained from off-site potable sources or nearby Moon Lake facilities. No waste water will be generated. Surface runoff water erosion protection and dust control water are described in Section H of the Supplemental Discussion.

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C. **Solid Wastes.** Describe the quantity and the physical and chemical characteristics of solid waste produced by the operation. Describe how the wastes will be disposed of including location and design of facilities, or treated so as to minimize adverse impacts.

No solid waste will be generated. All natural limestone rock and topsoil overburden will be utilized during reclamation work to provide stable slopes and as fill. No tailing will result from test pit work.

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D. **Scenic Values.** Describe protection of scenic values such as screening, slash disposal, or timely reclamation.

Test pits and access road are not visible from the existing public roadways or Moon Lake recreational facilities. Work is being performed on an existing natural slide zone to mitigate visual impacts, with the site visible only from a small section of a hiking trail. Terraced reclamation with natural rock gabions and vegetated rock nets will be performed immediately upon completion of test pit excavation and is part of the planned work for this season. See Section C of the Supplemental Discussion for aesthetic value of this type of reclamation.

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*(If more space is needed to fill out a block of information, use additional sheets and attach to form.)*

- E. **Fish and Wildlife.** Describe measures to maintain and protect fisheries and wildlife, and their habitat (includes threatened, endangered, and sensitive species) affected by the operations.

No impact to fish or wild life is anticipated from the development work. Road maintenance, terracing and re-vegetation work have historically reduced sedimentation (sedimentation analyses are provided in Section H of the Supplemental Discussion). Analysis indicates that planned reclamation work will create no additional sediment when compared to the existing slope. Use of hay bales, road edge berms and bar ditches will control rain-induced sediment during test pit excavation and sample removal portions of the work. FS analysis done in 1994 indicated that this project was unlikely to effect any TES species. FS is to provide further TES evaluations in the planned EA for this development phase.

- F. **Cultural Resources.** Describe measures for protecting known historic and archeological values, or new sites in the project area.

Archaeological surveys performed for 1978 for access road corridor construction cleared the area of cultural resources. FS is to provide an expanded area cultural resource evaluation in the planned EA for this development phase. UMCC desires to keep open access to natural pigment minerals for regional Native Americans who have historically utilized these materials for cultural ceremonies and will work with the FS and these groups to formalize an agreement.

G. **Hazardous Substances.**

1. Identify the type and volume of all hazardous materials and toxic substances which will be used or generated in the operations including cyanide, solvents, petroleum products, mill, process and laboratory reagents.

No milling or refining will be done in the forest. Excavation and sample removal does not require use of any hazardous substances. No hazardous substances are anticipated or planned for use. Detailed handling information for equipment fuel and other equipment-related fluids is presented in Section J of the Supplemental Discussion.

2. For each material or substance, describe the methods, volume, and frequency of transport (include type of containers and vehicles), procedures for use of materials or substances, methods, volume, and containers for disposal of materials and substances, security (fencing), identification (signing/labeling), or other special operations requirements necessary to conduct the proposed operations.

Not applicable.

*(If more space is needed to fill out a block of information, use additional sheets and attach to form.)*

3. Describe the measures to be taken for release of a reportable quantity of a hazardous material or the release of a toxic substance. This includes plans for spill prevention, containment, notification, and cleanup.

No hazardous material use is anticipated. Construction equipment will be checked daily for fuel or oil leaks. If a leak is discovered from a vehicle, the volume lost and the cleanup measures will be documented and the FS will be contacted immediately. Any fuel-contaminated soil will be excavated and removed to an appropriate disposal facility.

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- H. **Reclamation.** Describe the annual and final reclamation standards based on the anticipated schedule for construction, operations, and project closure. Include such items as the removal of structures and facilities including bridges and culverts, a revegetation plan, permanent containment of mine tailings, waste, or sludges which pose a threat of a release into the environment, closing ponds and eliminating standing water, a final surface shaping plan, and post operations monitoring and maintenance plans.

Installation and evaluation of reclamation methods is a significant element of the proposed test pit activities. This work is detailed in Sections B through D of the Supplemental Discussion. The majority of the access road is and will remain part of the FS system and cannot be reclaimed. 0.17 acre of spur road reclamation will be performed during test pit work (see Maps 3 and 4). UMCC has an established plan on file with the FS for reclamation of the remaining road segment and will post a bond to cover future costs for road reclamation work.

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## **VI. FOREST SERVICE EVALUATION OF PLAN OF OPERATIONS**

- A. Required changes/modifications/special mitigation for plan of operations:

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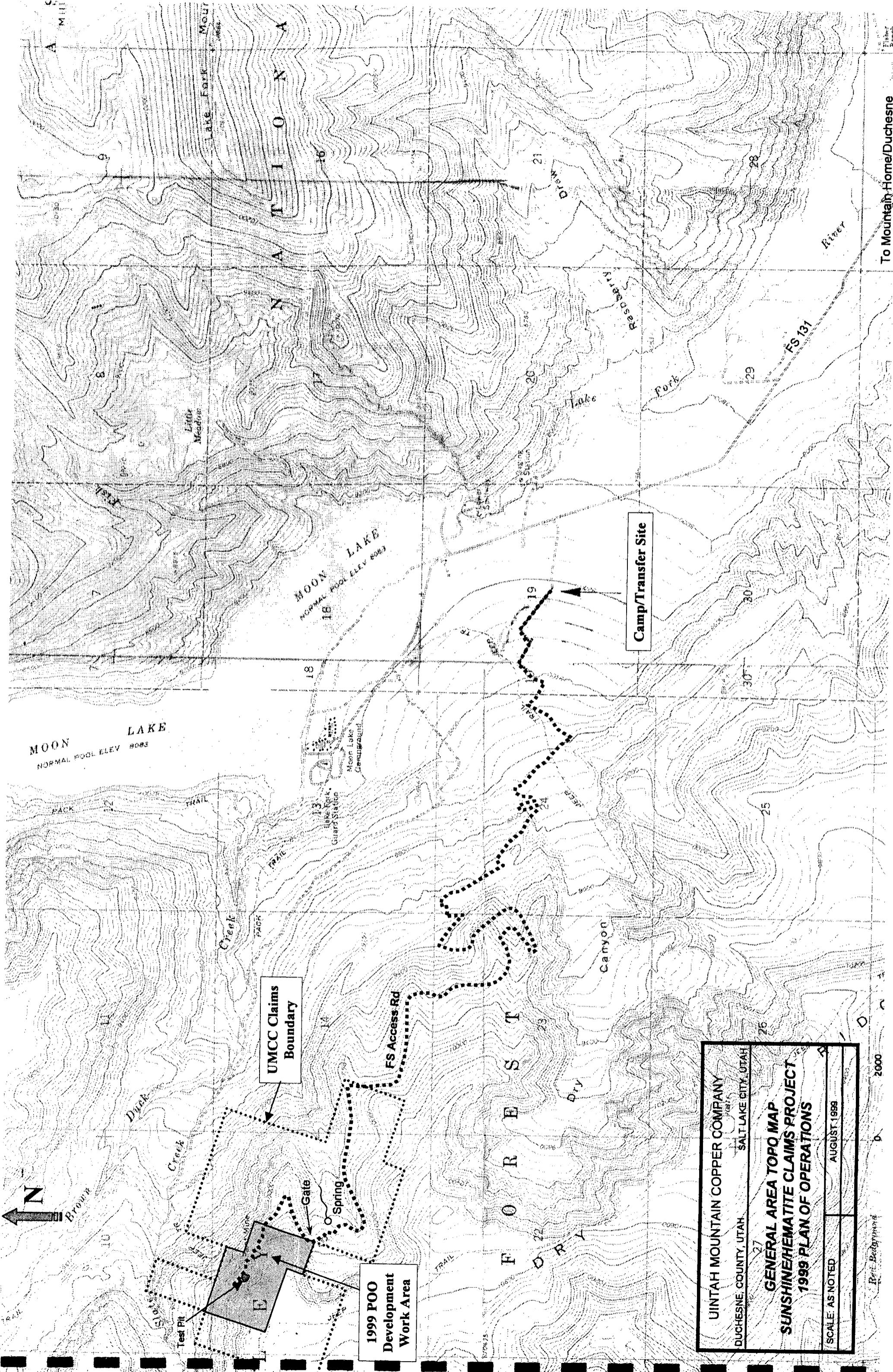
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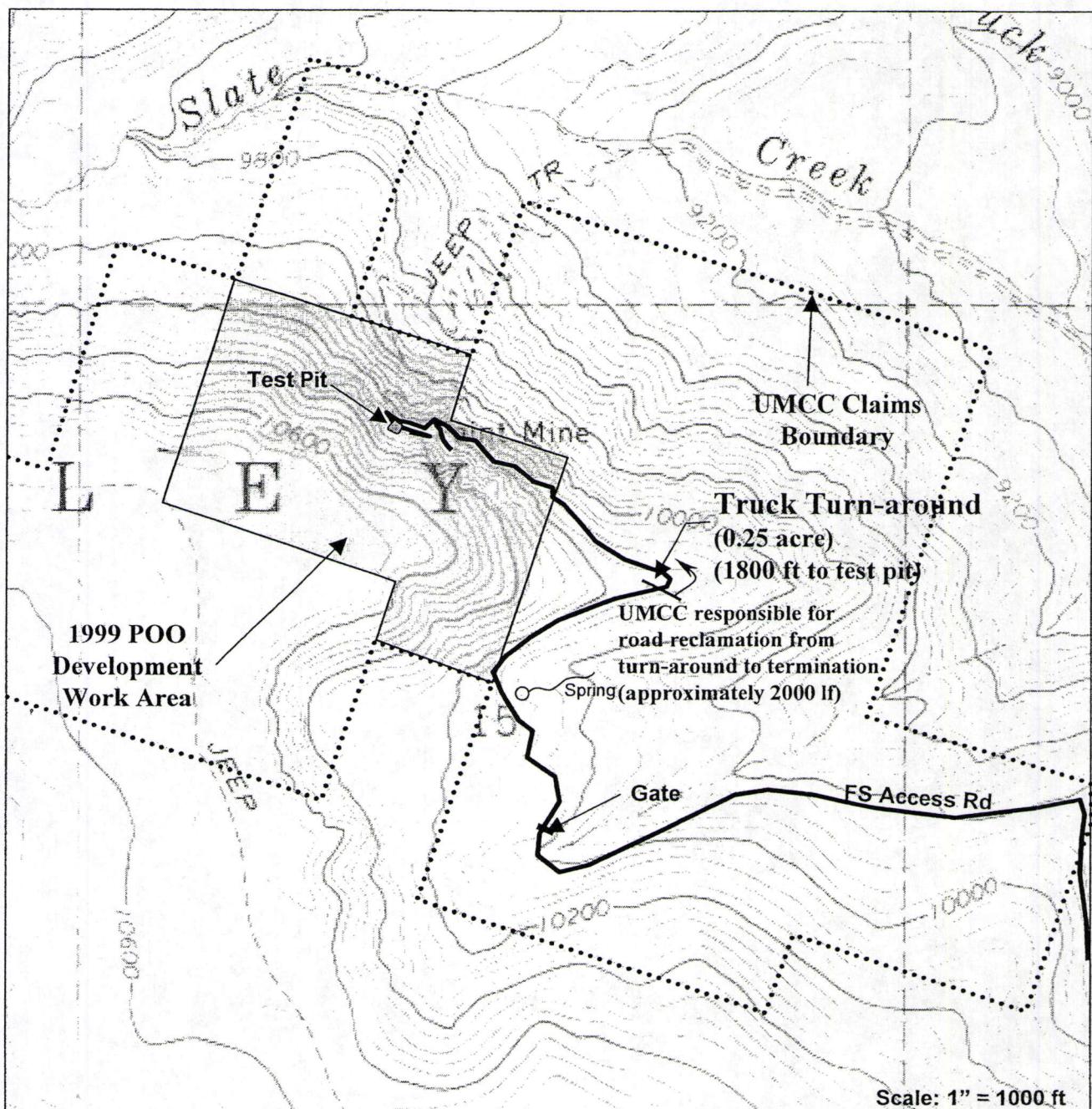
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## MAP 2



### Sample Ore Transport Route Map

Access Road North (uphill) of Gate:

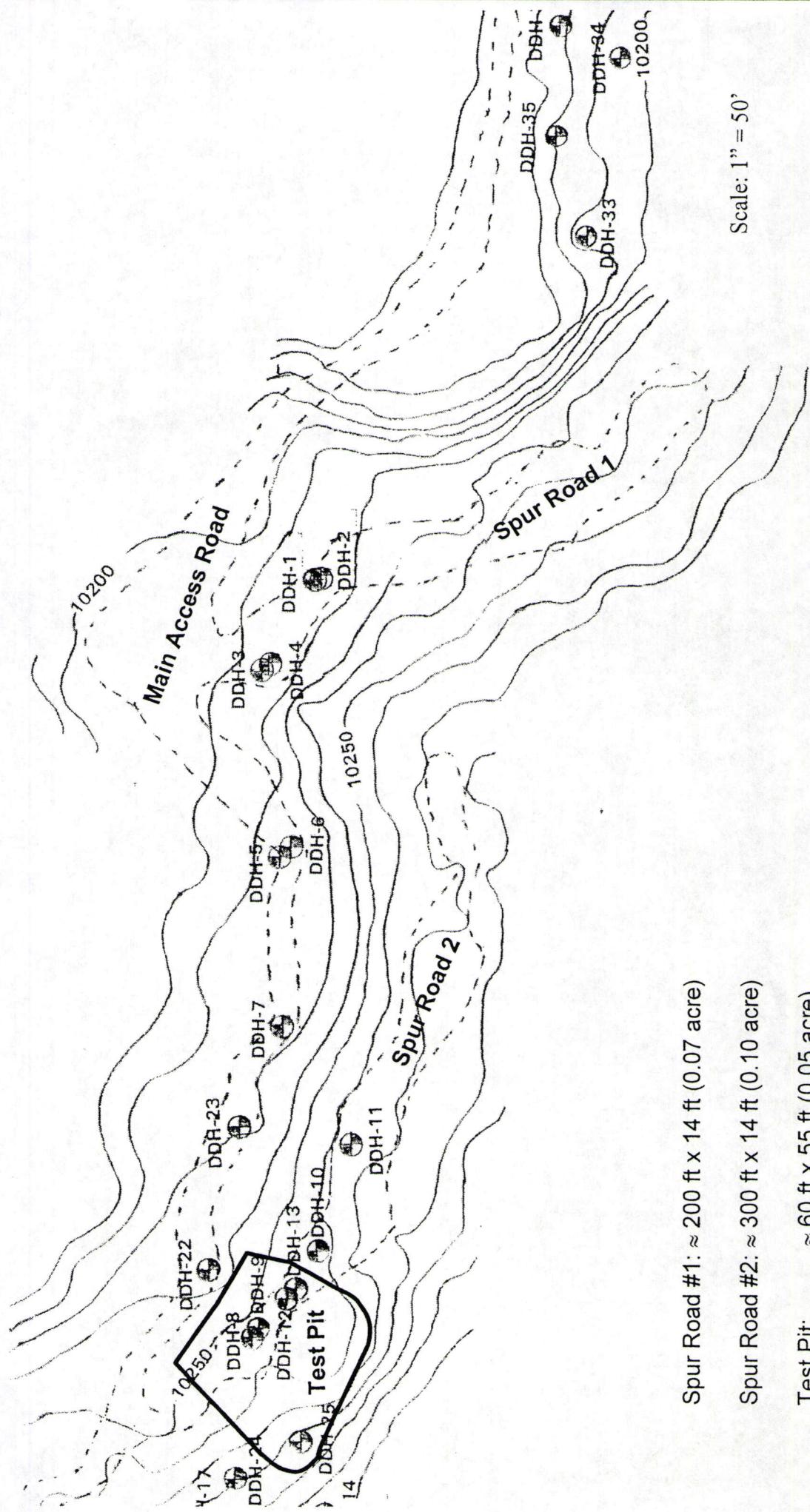
≈ 4000 ft x 12-14 ft (1.2 acres)

(UMCC calculations)

≈ 3600 ft x 12-14 ft (1.1 acres)

(USFS calculations)

MAP 3



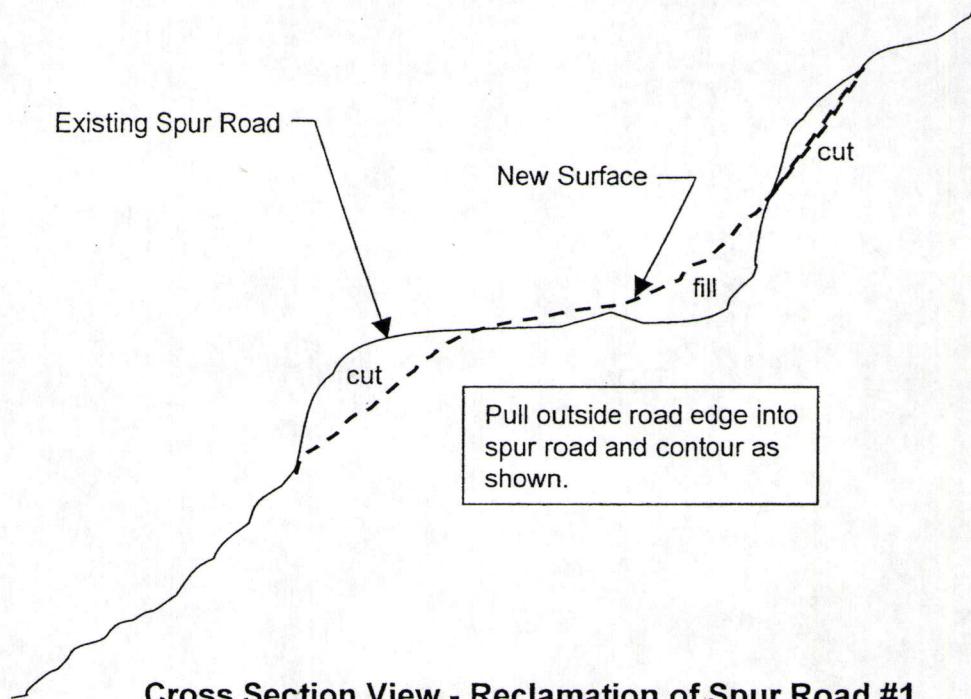
Scale: 1" = 50'

Spur Road #1:  $\approx 200 \text{ ft} \times 14 \text{ ft}$  (0.07 acre)

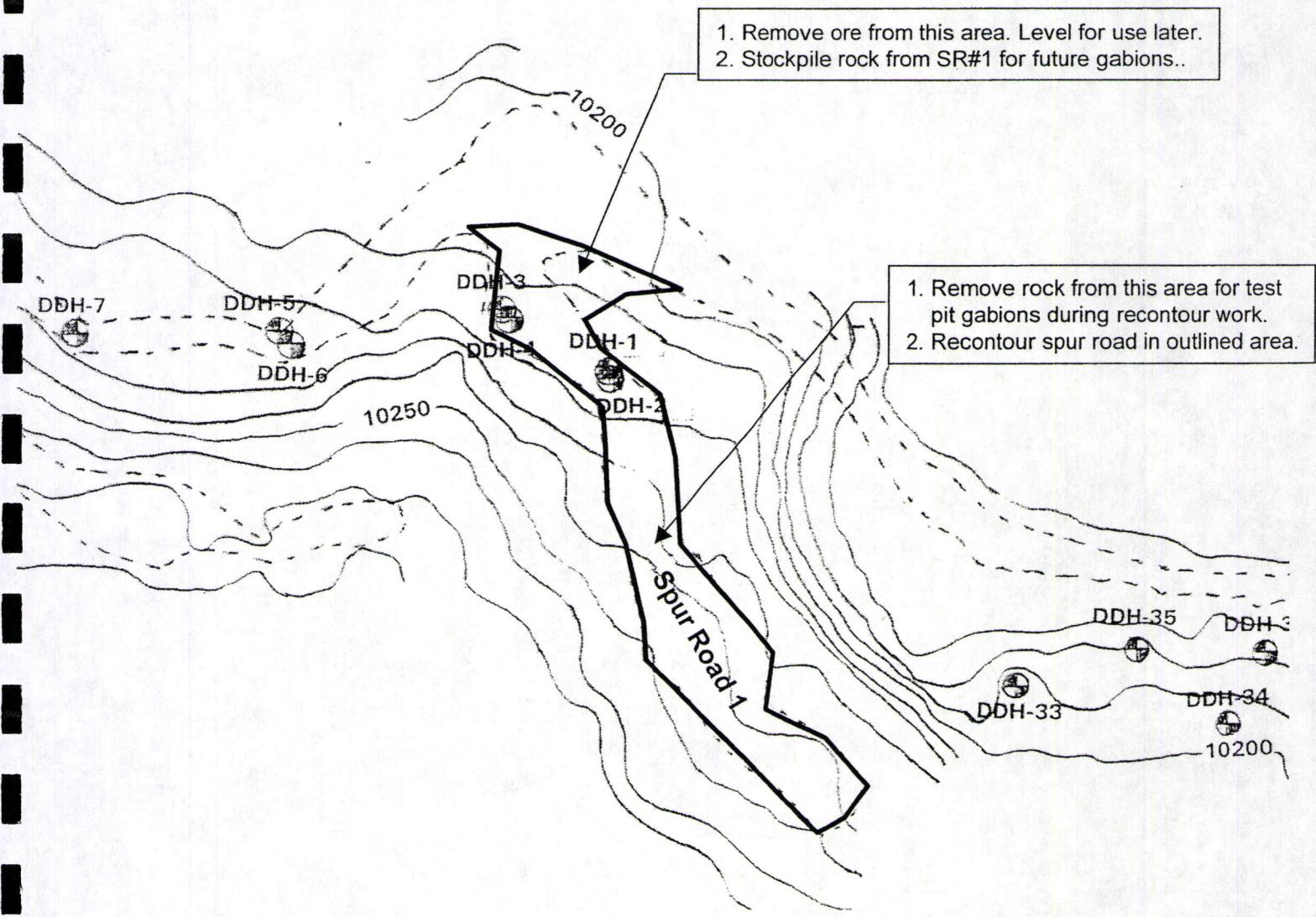
Spur Road #2:  $\approx 300 \text{ ft} \times 14 \text{ ft}$  (0.10 acre)

Test Pit:  $\approx 60 \text{ ft} \times 55 \text{ ft}$  (0.05 acre)  
(excludes SR#2 overlap area)

Spur roads to be closed as part of pit development work Summer 2001

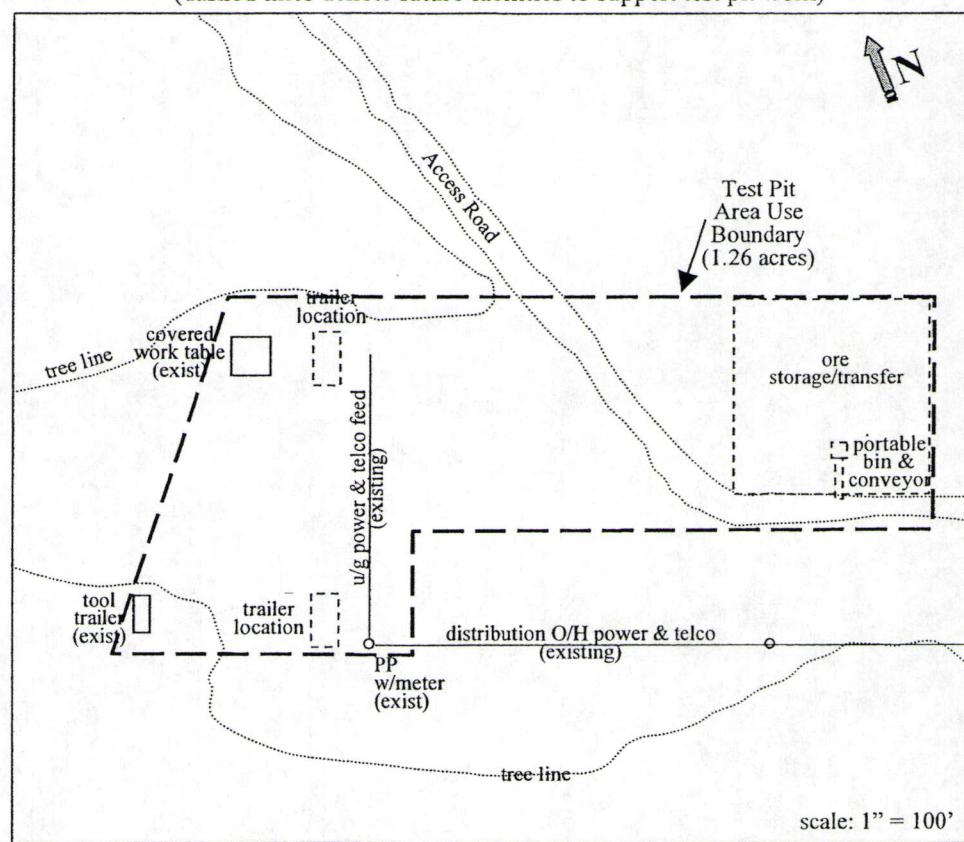


Cross Section View - Reclamation of Spur Road #1



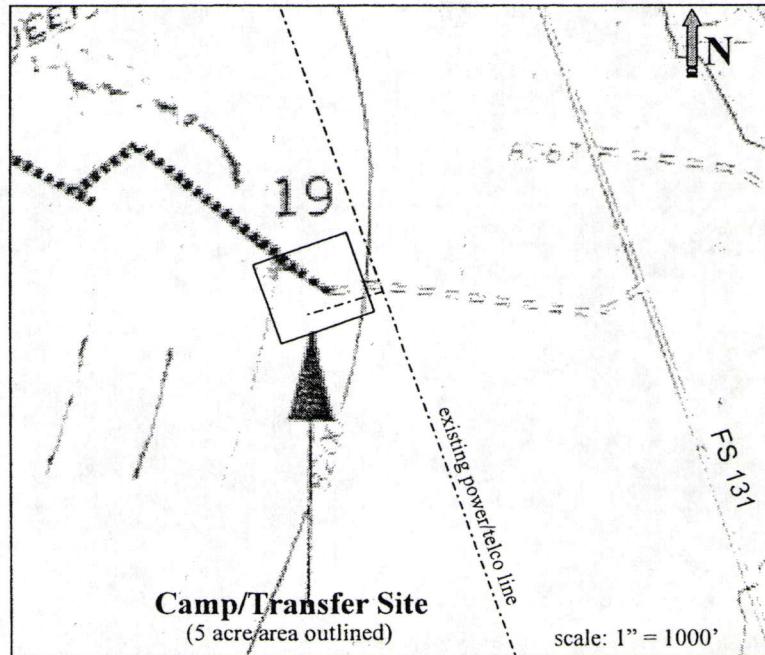
**Camp/Transfer Site**

(note: structure locations have not been surveyed in and are shown as approximate  
(dashed lines denote future facilities to support test pit work)



**Camp/Transfer Site**  
(5 acre area outlined)

scale: 1" = 1000'



## Supplemental Discussion to 1999 Plan of Operations

### A. Project Description – Phase 3 Test Pit

Proposed development work is the final phase of a three-phase test pit program designed to simulate ore removal and reclamation activities in a controlled location and manner while verifying the deposit geologic structure model developed from the 1994-95 drilling programs. A small test pit planned as the last phase in this development program should extract about 650 cubic yards of raw sample ore and reclaim a 250 square yard sample area over a 60-day work period. No waste rock results from the operations and all sample will be hauled from forest lands for further processing (no on-site milling or tailings). Small-scale test pits provide a wealth of economic and environmental reclamation data for evaluating the future mining potential of the project. All previous development phases were reviewed and approved by the US Forest Service prior to initiation. The test pit configuration has been revised per Forest Service recommendations in May 2001.

Work will be performed sometime after August 2001, once the EA has been approved. The following schedule has been developed based upon Phase 1 and 2 site work:

Activity	Time Length	Labor
Road preparation and mobilization	6 days	3 men
Overburden removal and stockpile	20 days	3 men
Ore sampling and hauling	16 days	8 men
Reclamation activities	18 days	10 men

The total summary of acreage involved with the test pit project is shown.

	<u>Presently Disturbed Area</u>	<u>Total Disturbed/Used Area including POO Activities</u>
Access/Spur Roads	1.37 acres	1.62 acres
Camp Site	0.01 acre	1.26 acres
Mine Pit Area	0.00 acre	0.05 acre
Totals	1.38 acres	3.17 acres

The attached quad and site maps show the location of the development activites. Detailed work descriptions are also provided in the documents referenced in Section L.

### B. Material Excavation, Removal and Backfill

Figures A through D demonstrate the sequencing of excavation and backfill of the proposed sample pit. An estimated 650 cubic yards of sample ore will be removed from the area. All of the remaining 2000 cubic yards of native limestone rock and topsoil overburden will be incorporated into the reclaimed and stabilized slope with no tailings or waste rock for disposal. The shape and dimensions of the test pit have been revised to accommodate Forest Service geotechnical engineer recommendations of 11/30/98 and 4/16/2001. Existing conditions are shown in Figure A.

Topsoil and fractured limestone rock overburden (noted as "TBS" or "thinly bedded series") will be excavated and placed as backfill with track-mounted equipment. Based upon previous site work and drill log data, no blasting is anticipated or planned. A combination of one Caterpillar D7 or D8-size bulldozer and one or two Caterpillar 312 or 315 excavators will remove overburden materials. This overburden will be placed in uniform lifts along the adjacent access road to a 5 to 10 foot depth by use of the bulldozer and a 1.5 to 2.5 cubic yard track-mounted front end loader. All of the proposed equipment have been previously used at the site with good results. Because of the confined area in which the equipment will function, the estimated time to accomplish all overburden removal has been doubled from known on-site performances to allow for safe operation. Based on previous time studies at this site, overburden can be safely removed and stockpiled at the rate of 5 to 10 cubic yards per hour per piece of equipment.

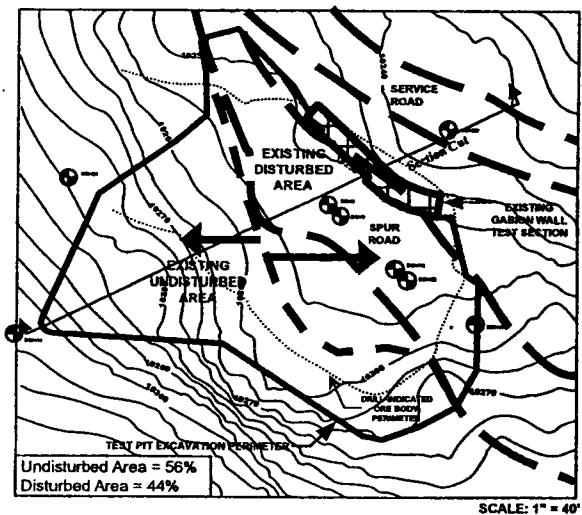
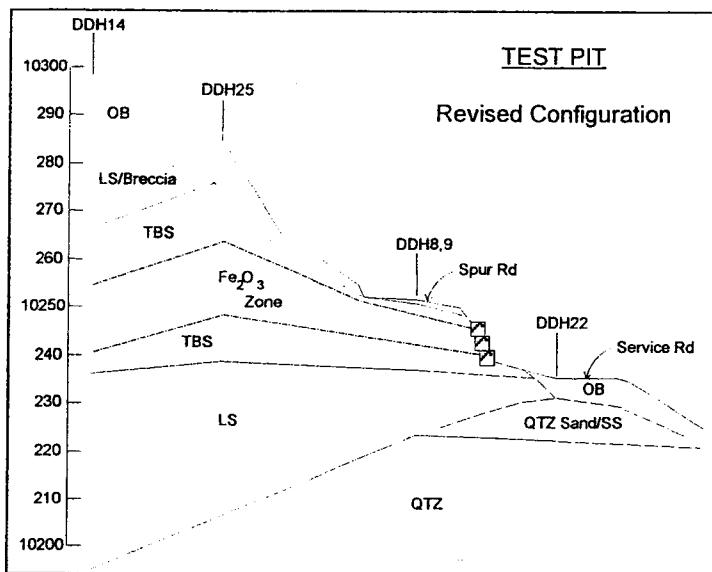
The existing upper spur road will be cleared of sloughed material to allow access to the top of the slope and overburden slopes above the test pit will be cut to a flatter slope (approximately 1:1) for stabilizing (Figure B). The bulldozer will cut into the hillside at the top of competent rock to form a 10-foot wide working bench (cut and fill). Top of rock is expected to range from Elev. 10255 near the spur road to Elev. 10274 at the northwest corner of the pit. The bench will allow the excavator access to the top of the slope (maximum planned reach of 20-30 feet to the top of the cut at about Elev. 10300). Once the overburden along the bench has been removed and the cut slopes above are contoured, the majority of remaining overburden will be removed to Elev. 10260.

Sample ore and remaining overburden will be removed sequentially (as shown in Figure C) by combined use of the bulldozer, loader and excavator (not all at the same time). An access ramp behind the existing gabion wall will be cut for pit access to Elev. 10242. Approximately half of the sample ore will be removed while extending the top slope cut to Elev. 10255. A maximum 12-foot high 5:1 (vertical:horizontal) slope will result from this first phase of ore removal. The final stage of ore and overburden removal will extend the pit to the northwest, producing a maximum 5:1 cut slope face of 27 feet. During this part of the work, the bench at the top of the slope will be trimmed of loose material and range from 3 to 5 feet in final width.

The pit will be backfilled by following the process in reverse and using the adjacent spur road for access to the upper reaches of the cut (Figure D). Overburden will be placed behind the existing gabion (one additional 1.5-foot tall basket lift will be placed at the time of fill) to the base elevation of the next higher gabion system (Elev. 10254.8). A one foot thick drainage layer will be placed along the bottom and sides of the excavation. This layer will be covered with a filter fabric to prevent migration of fines from the remainder of the backfill. Geogrid layers (Maccaferri Paragrid 50/15) will be place along the top of the drainage filter and laterally at two gabion lifts. The second wall system will be placed to a final elevation of 10263.8, in the same manner as the first wall system, but with three geogrid layers. The terrace created by backfilling behind this wall will be sloped back slightly to the rock face to create a catchment for rock and soil from upper elevations. All backfill will be compacted with the on-site construction equipment to about 90% of maximum standard proctor density. Upon completion of the second wall system, a rock net will be installed along the remainder of the open cut rock face. Once all upper level work is complete the upper gabion wall will be extended to the southeast and the existing lower gabion wall will be extended to the northwest, with final backfill placed from in front of each wall by use of the excavator. Compaction in these isolated areas will be done with small riding or hand-operated equipment.

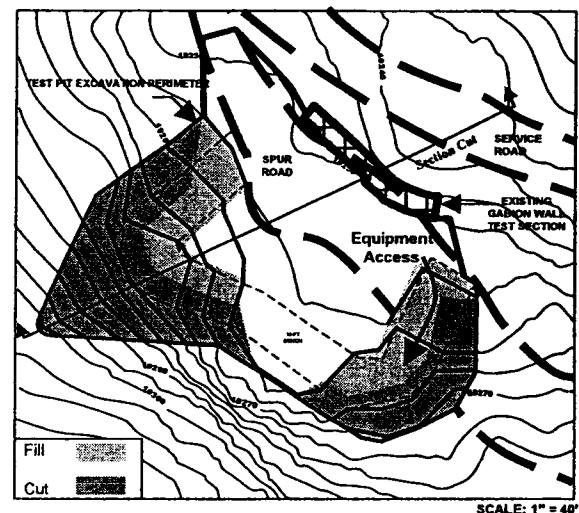
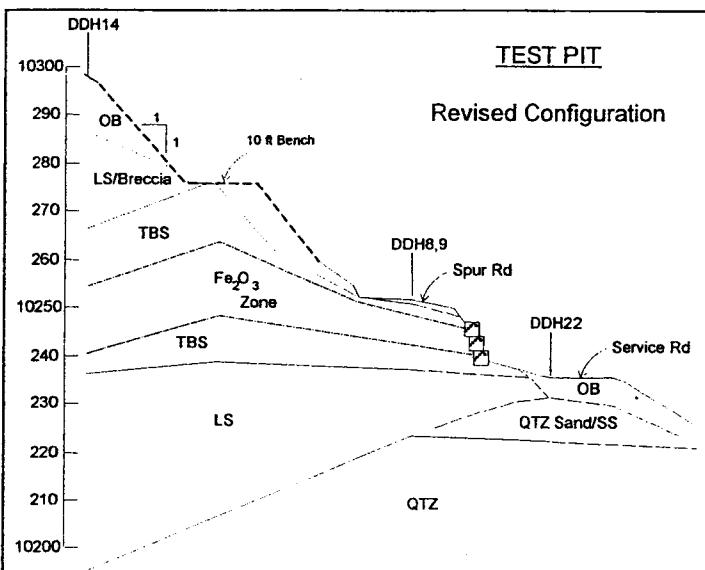
Native overburden topsoil will be replaced on the reclaimed terraces. There will be an attempt to segregate topsoil from overburden. All segregated topsoil will be stockpiled for use in the

Figure A

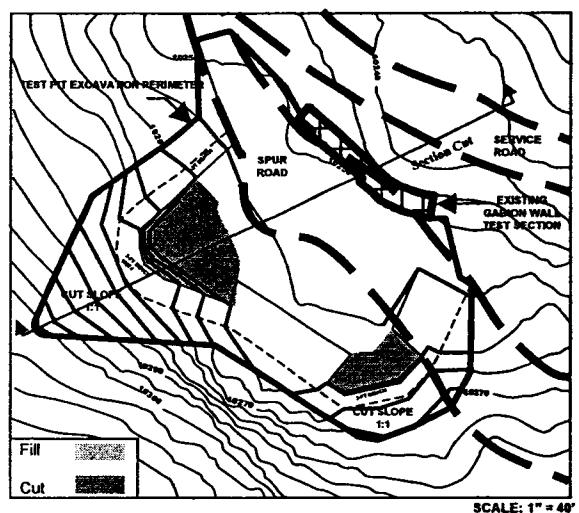
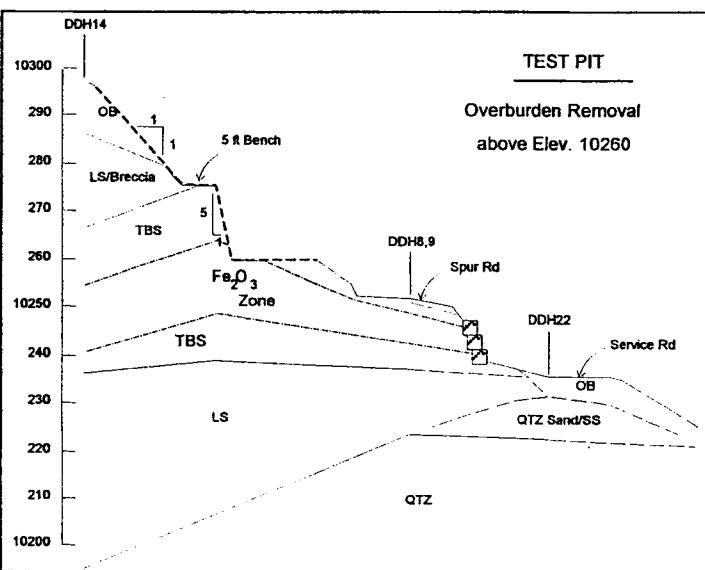


Revised Test Pit Configuration: Staged Excavation - Pit Area

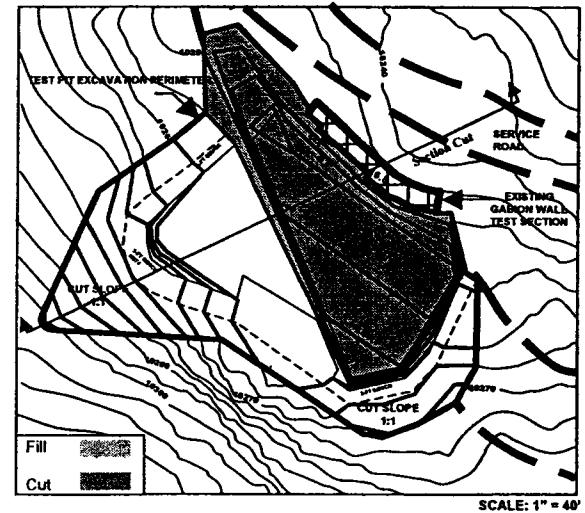
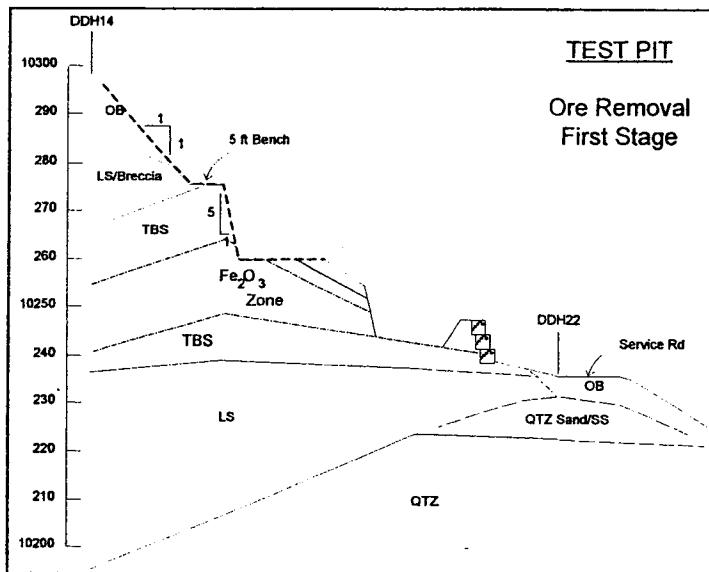
**Figure B**



### Revised Test Pit Configuration - Staged Excavation Overburden Removal



**Figure C**



**Revised Test Pit Configuration - Staged Ore Removal**

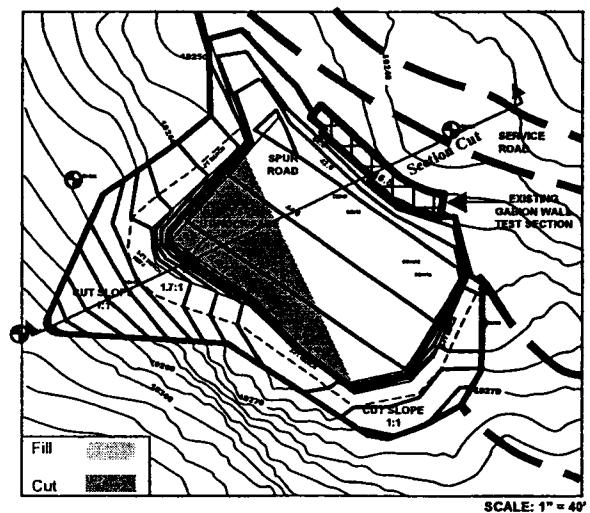
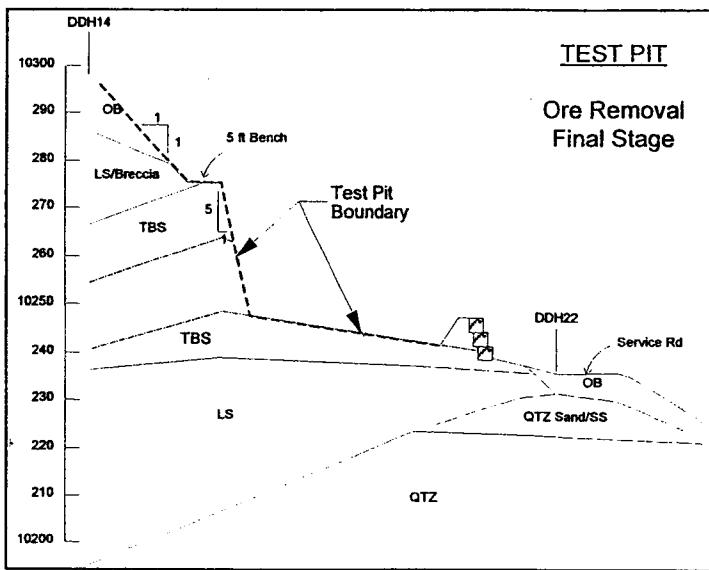
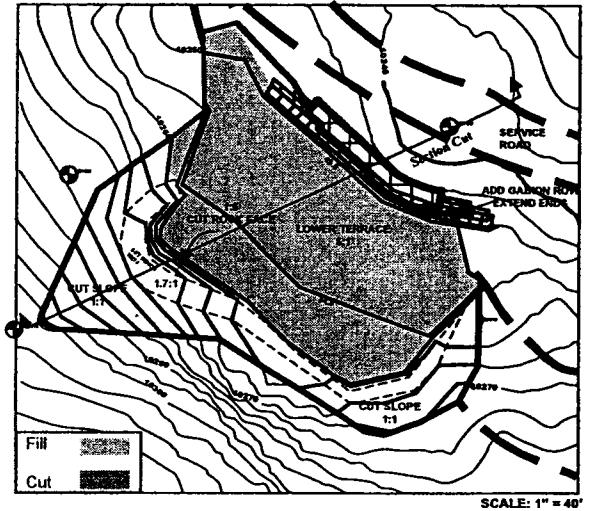
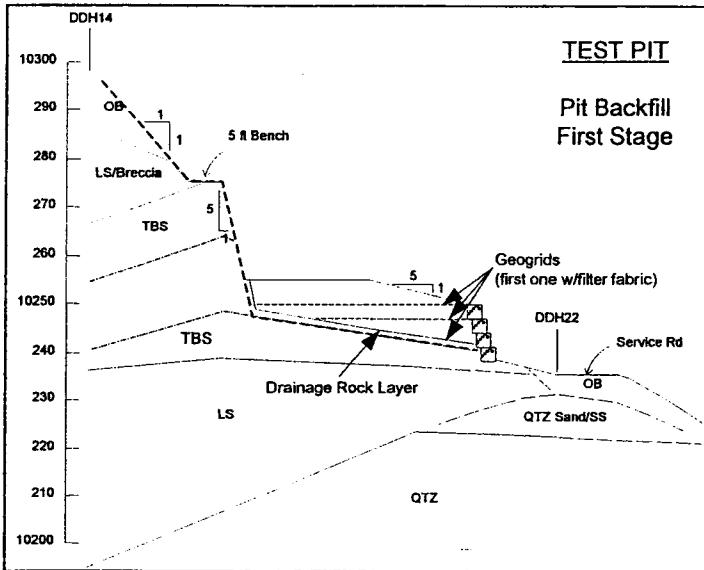
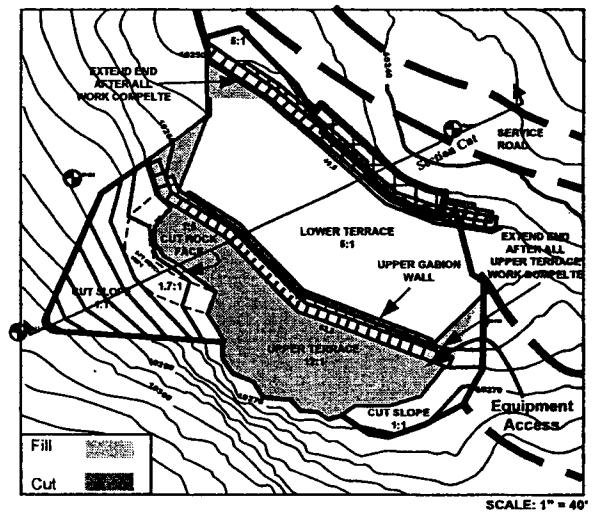
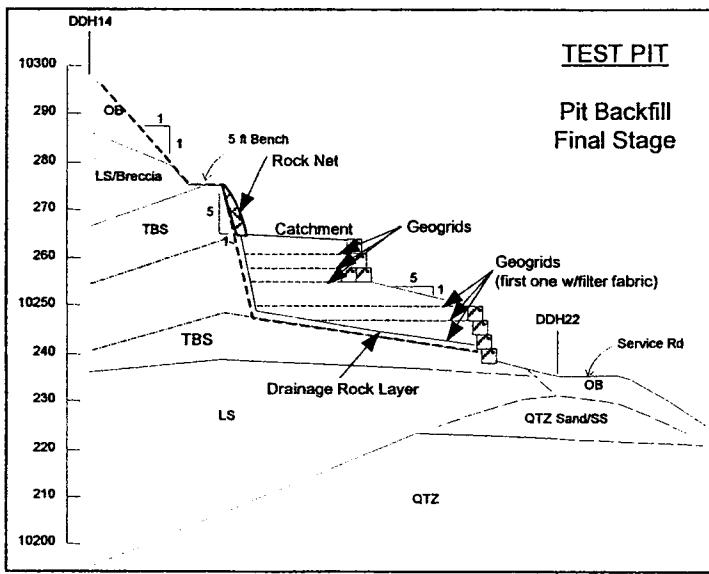


Figure D



### Revised Test Pit Configuration: Staged Excavation - Gabion Installation



reclaimed slope. Any additional topsoil needed to establish vegetation and prevent short-term erosion will be borrowed from local sites as recommended by the USFS at the time of work.

The test pit location was selected because it is primarily within an already disturbed area. Vegetation covers only about 100 square yards of the 250 square yard selected test pit location. It is estimated that less than one 5-ton truck load of small trees and bush will be generated from this test pit operation. In the past, the Forest Service has requested that this minor vegetation be incorporated within the edges of fills to promote growth and inhibit erosion. Since salvaging of topsoil will be a high priority during excavation, all removed vegetation will be combined with the topsoil and either mulched or blended (depending upon piece size) to enhance top soil nutrients and inhibit erosion. No vegetation disposal is anticipated, rather, the minor vegetation will be incorporated within the topsoil during reclamation.

Work will proceed around any anomalous zones of non-rippable rock encountered during excavation. Since this work is part of a development program (not production mining) complete excavation is not required. Historically, blasting at the site has only been needed when excavating into quartzite deposits that underlie the ore body. All planned work will be done above this harder strata.

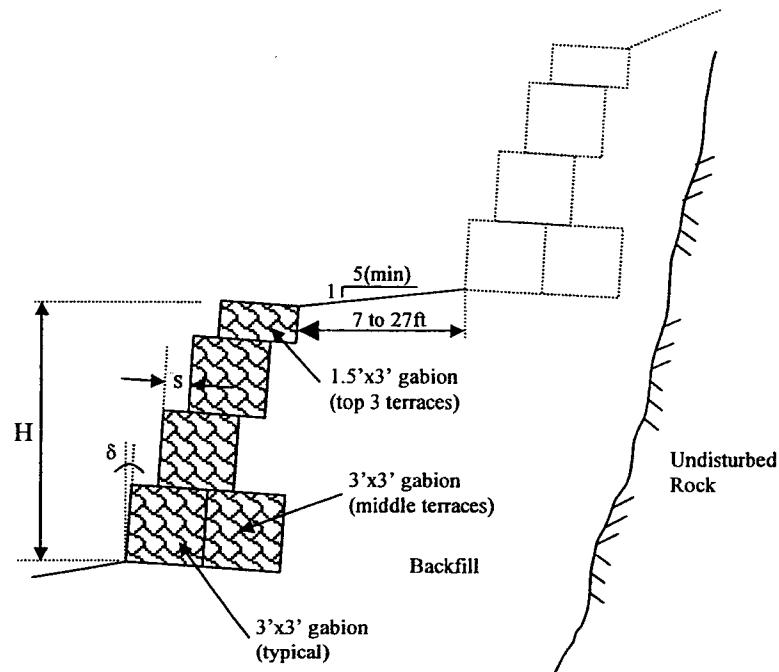
Additional miscellaneous equipment includes fuel and maintenance trucks to service vehicles at the test pit site and the camp site. A water truck will be used as needed to control dust.

All work will be performed on non-holiday weekdays.

C. Reclamation

Site reclamation incorporates the use of terraced embankment with levels restrained from movement using gabion rock walls. Steep side slopes ( $30^{\circ}$  to  $40^{\circ}$  from horizontal) preclude laying back of the hillside to a stable natural slope without a support system. UMCC has historical success at terrace stabilization of this area. The original switchback road across the toe of the slide zone was terraced and reclaimed by UMCC in 1980. Since that time, vigorous vegetation growth has been observed, significantly reducing sedimentation from the natural slide area. Review of projects worldwide show that similar steep slopes in slide zones have been successfully stabilized by terracing with gabion structures (Maccaferri, 1995).

Gabion rock walls (rock-filled wire baskets) create retaining structures that have a natural appearance, adapt to difficult sites, require little to no maintenance and can easily be vegetated. Reclamation of the Phase 3 pit area requires the placement of a series of two gabion retaining structures comprised of up to four basket rows ranging from 40 to 80 feet in length, placed up to 10 feet above adjacent terrace grades at step-back slopes of 70 degrees (see Figure E). Rock backfill incorporates native fractured limestone and fine soils near the top of baskets to encourage vegetation growth on and above the retaining structures.



Wall height,  $H$ , varies from 8 to 10.5 ft  
 Gabion baskets stagger,  $s$ ,  $12\pm 3$  inches  
 Wall inclination at time of construction,  $\delta = 10^\circ$  to  $15^\circ$

**Figure E**

**Illustration of Typical Gabion Rock Wall Section**

The first 9 foot high gabion rock test wall was placed in 1997 for reclamation of Phase 1 and modified Phase 2 work. The condition of this structure has been observed and documented each season to evaluate the effectiveness of this type of stabilization method at the site. The wall has functioned well, with only a slight forward rotation after initial placement and some washout of fines within individual baskets. Vegetation actively grows on the face of the wall and upon the supported terrace. The wall appearance (color and texture) blends in well with the surrounding native rock. Figures F and G show the wall at time of placement and after one year of service.

Gabion wall construction equipment and sequence is provide in Section B of this discussion. Gabion baskets require no concrete foundations and are primarily hand-placed with manual labor. Time studies performed during test wall construction indicate that the 300 cubic yards of gabion wall planned for Phase 3 reclamation can be erected at this site at the rate of at least 25 cubic yards per day. A small 1.5 cubic yard loader supports most of the fill operations, with the small D7 bulldozer and 312 excavator placing and compacting fill in and behind walls. Wall erection will be expedited by pre-screening and stockpiling of basket rock prior to the start of wall construction.

It is estimated that the drainage system and gabions will require about 300 cubic yards of screened rock fill. The remainder of the backfill needed to reclaim the slope and terraces is reduced to 1300 cubic yards. Combined backfill requirements reduce to 1600 cubic yards, or 80% of removed non-ore material. A review of the drill logs indicate that about 700 cubic yards of good quality gabion rock will be available from the excavation area. If additional gabion material is needed, high quality gabion rock can be obtained from along the upper slopes of Spur Road #1 (200 feet long). It is estimated that 0.5 to 1.0 cubic yard of gabion rock per linear foot of road can be removed during road reclamation to supplement the process.

Use of gabions for local slope stability in this difficult terrain is also documented in a paper presented at the 37<sup>th</sup> US Symposium on Rock Mechanics in 1999, with the paper featuring this UMCC site.

Seeding will be performed on terraces upon completion of backfill operations, and will incorporate a Forest Service approved mix of equal parts of Nezpar Indian rice grass, Secar Blue Bunch wheat grass and Sheep fescue applied at the minimum rate of 3 pounds per 1000 square feet of area. Seedlings will also be planted upon request by the Forest Service.

Previous road seeding on an abandoned switchback access road performed by UMCC in the early 1980's provided temporary vegetation until the natural grasses and plants eventually became established. Empirical evidence on the existing 6.5 mile access road suggests that natural seeding is aggressive and the most effective and long-lasting form of disturbed area re-vegetation.

Cut slopes above the test pit will require both seeding and supplemental control practices to mitigate excessive sediment transport and erosion. Water quality analysis (Section H) recommends application of either Excelsior blankets or wood fiber slurry to exposed cut slopes and the lower terrace to reduce sediment to acceptable levels.



Figure F - Gabion Test Wall: September 1997



Figure G - Gabion Test Wall: August 1998

#### D. Excavation and Reclamation Slope Stability

Extensive geotechnical analyses and evaluations have been performed by UMCC and the Forest Service on excavation and gabion wall stability. These are documented in previous correspondence and the 6/3/99 UMCC engineering report to the Forest Service, with excerpts provided herein. A revised slope stability analysis for the reconfigured test pit area is attached in Appendix C.

Drill logs at the test pit location show that the unconsolidated slope overburden ranges from 5 to 9 feet in thickness. Below this material is fractured rock that becomes significantly more competent with depth at 7 to 16 feet below the top of the cut. Rock below this depth is bedded into the hillside and does not daylight, allowing near vertical slopes (see previous correspondence on this issue from 1995). Minor rock raveling within the limestone strata are easily controlled by cutting the slope to the planned 5:1 slope (V:H). This is in agreement with most standard texts (Rodriguez, et al. note slopes cut in similar materials ranging from 4:1 to 8:1). Rock scaling with this configuration is not anticipated.

Tables 1.0 and 2.0 provide slope stability results from the revised configuration:

**Table 1.0 Gabion Wall Stability Analysis Summary**  
(RS = reinforced soil with geogrids)

Wall Case	Backfill Only		Backfill w/equipment Loads <sup>(1)</sup>		Backfill with surcharge on catchment	
	w/out RS	W/RS	w/out RS	W/RS	w/out RS	W/RS
Lower Wall						
sliding	4.48	— <sup>(2)</sup>	2.55	—	—	—
overturning	2.66	—	<b>1.66</b> <sup>(3)</sup>	—	—	—
base stability	2.02	2.44	1.45	1.86	—	—
Upper Wall						
sliding	negligible	—	5.17	—	7.03	—
overturning	16.7	—	6.93	—	5.70	—
base stability	1.59	2.50	1.21	1.70	<b>1.31</b>	2.04

(1) Considered a transient (temporary) load condition, lower safety factor acceptable

(2) Items left blank were non-applicable to the analysis method

(3) Items in **bold** indicate low safety factor

**Table 2.0 Slope Stability Analysis Summary**  
(RS = reinforced soil with geogrids)

Condition	Surface Failure		Deep Seated Failure		Backfill Failure	
	w/out RS	W/RS	w/out RS	W/RS	w/out RS	W/RS
Existing Slope	<b>1.28</b>	— <sup>(2)</sup>	1.82	—	—	—
Excavated Pit <sup>(1)</sup>	1.32	—	1.72	—	—	—
Reclaimed Pit	<b>1.32</b>	—	1.84	1.93	1.81	2.22

(1) Considered a transient (temporary) load condition, lower safety factor acceptable

(2) Items left blank were non-applicable to the analysis case

(3) Items in **bold** indicate low safety factor

Overall slope stability of reclaimed test pit area is equal to or slightly better than existing conditions. Potential for near surface slope failures remains high, but inclusion of catchment in reclaimed gabion design prevents loss of material downhill. Potential for deep seated failure decreases with inclusion of soil reinforcement (minimum factor of safety increases from 1.82 to 1.93).

Use of soil reinforcement allows for safer construction and long-term stability of gabion wall embankments. Base stability of the lower and upper walls increases during and after installation when using soil reinforcement 20-28 percent and 40-57 percent, respectively. Overall backfill stability increases 22 percent.

Minimum slope stability safety factors of 1.32 for near surface failures above the test pit area and 1.84 for deep seated failures through the toe of the pit are acceptable for short term conditions (greater than 1.2).

To prevent possible overturning failure, heavy earthmoving equipment should not be placed within 10 feet of the edge of the lower gabion wall once fill has been placed to the final elevation. Lighter equipment should be used for final lift compaction.

The upper gabion wall (with soil reinforcement) can safely support potential overburden soil failures from slopes above the test pit area. The minimum slope stability safety factor is 2.04.

The test wall was originally designed as a three-tiered, stair-stepped vertical gabion structure. During placement of backfill, the top of the wall rotated forward from 0 to 2 feet off alignment to the present observed state, presenting a near-vertical wall. As a test of live load stability, heavy equipment was placed above the wall and within 1 foot of the gabions immediately after backfill. No additional movement was observed. One year after installation, a CAT 312B excavator performed additional sample removal work within 3 feet of the wall. No movement was observed from this equipment activity.

Further analyses have been performed to verify that the wall safety. The wall was modeled in a worst-case configuration, assuming all tiers rested in a vertical alignment. Table 3.0 gives a summary of the analyses, including the original design case, the as-built (model) configuration and this same configuration with design equipment loads. Although stability is lower than originally anticipated, the wall still functions safely, meeting minimum standard industry safety factors for long-term and transient loadings.

Table 3.0 – Safety Factor Analyses Summary of Gabion Wall

Analysis Case	Factors of Safety			
	Sliding	Overturning	Slope Stability	Bearing
Design (no loads)	7.37	6.51	2.57	14.5
As-Built	5.20	3.12	2.72	7.40
As-Built w/loads	3.11	2.36	2.19	5.61

This construction and analysis information indicates that future gabion walls should be inclined into the hillside 10° to 15° from vertical to compensate for construction-related outward rotation from backfilling.

## E. Material Handling and Transport

Access to the test pit is via the existing Forest Service access road. No new road construction is required. The access road meets minimum width requirements for all equipment and has been utilized by all proposed equipment in the past. 12-ton 10-wheel rear dump trucks will approach the site at a naturally wide 0.25 acre area about 1800 feet from the pit area for loading (see Map 2). No grading or earthwork (disturbance) is required at this location to allow trucks to turn around or to place portable ore conveyance equipment since the location is on a very broad and level ridge. 5-ton trucks will transport ore from the pit area to this.

Overburden will be placed as temporary fill on the access road directly below the pit area extending to the original adit. No vehicles other than approved haul equipment will travel on this road segment during the work. The access road in this section of the work is over 400 feet long and varies from 10 to 15 feet in width. In addition, approximately 600 cubic yards of overburden will be stored and processed for gabion/drainage rock along the 200 foot long by 15 foot wide Spur Road #1. This will allow the remaining 1400 cubic yards of overburden to be stored along the road (400 feet long, 12.5 feet wide, 7.5 feet deep). Map 3 provides a scaled map of the proposed areas. The overburden rock will be pushed by the dozer or placed by loader on the access road, leveled and moderately compacted into place with the same equipment until needed for reclamation. There will be an attempt to segregate and stockpile topsoil from the overburden.

A bin and conveyor at the camp site will also be used in lieu of a loading dock to off-load 10-wheel trucks into larger 20 to 30 ton trucks for long-haul of ore. All components will be portable and removed from the forest upon completion of annual activities.

Use of 10-wheel dump trucks during previous test phases doubled ore haul rates and reduced trip traffic on the access road. It was found that, with no additional road improvement, larger trucks could safely be brought within about 1000 feet of the main ore operations area. The planned turn-around site can safely be reached by these vehicles.

10-wheel trucks travel slightly slower than 5-ton trucks (8.5 mph versus 6.5 mph), but do no additional road damage. Observation of road conditions after large truck travel showed the slower, heavier trucks compacted loose surfaces on the road and produced divots only where the road was saturated. This work and previous experience demonstrates that it is very important to maintain a well drained surface to prevent erosion and protect against damage. It was observed by those at the site who have been present during previous site development projects that frequent trips by smaller pickup trucks have resulted in more detrimental road impacts since soft, saturated road sections are affected by all types of vehicles to about the same degree.

In well-drained areas (more than 90% of the access road), vegetation growth along with cobble rock plating cover the access road. Observations of road surface conditions were made prior to the start of haul and reclamation work and after completion of all Phase 1 and 2 activities. Although grasses and tree seedlings in the wheel paths were pressed onto the ground surface, nearly all vegetation was actively growing and appeared to be rebounding to original condition almost immediately after traffic ceased. Vegetation growth has been very aggressive during the latter 1990's on the road surface and may require some trimming in the future to allow safer vehicle access (not planned for Phase 3 work). The road in many areas appears more like a forest field than an unimproved access road. Isolated poor drainage conditions appear on less

than 10% of the road surface and are related to drainage features crossing the road path. There is less than 100 linear feet of rutting along the entire 6.5 mile access road.

From previous work phases, sample ore can be hauled at the rate of 2 cubic yard per hour per truck to the camp site 6.5 miles from the test pit. This rate includes return travel time to the loading area and loading time. For Phase 3 work, two 5-ton rear dump small trucks will haul from the test pit to the turn-around site (10 trips each per day, 30-45 minutes to fill, travel, unload and return), and two 12-ton, 10-wheel rear dump haul trucks will be needed for the remaining short haul to the camp site, with 4 trips per day. Two or three long-haul trailer trucks will be used each day to transport sample off the forest lands. The trailer trucks will utilize FS Route 131 and State Route 87 in Duchesne County to Carbon County along Highway 191, with round trip travel of 4 hours.

During Phase 3, three to five miscellaneous support vehicles will also travel to and from the site each day. These are primarily small pick-up trucks and SUV's to transport equipment operators, truck drivers, laborers, construction superintendent and geologist. The fuel/service truck will travel the road once per day and the water truck will be used as needed, up to three times per day.

#### F. Man Camp Site Features

No permanent structures are planned. A temporary facility covering 1.26 acres will be located at the permitted camp site area (see Map 5). Up to two portable trailers (max. 25 feet) may be used to house personnel and for use as a field office (camp has existing power and telephone connections). Potable water will be brought to the site in 10-gallon containers. Sanitation facilities will be self-contained portable units, primarily within trailers. Equipment fueling at the site and along the access road will be done via 3/4 ton service truck. Temporary ore storage and transfer at camp site will be done within a 100-ft square area by use of temporary bins and conveyors. The transfer area will not be graded, but will be covered with tarps underlain with pea gravel as needed to prevent sample contamination from the ground and provide a flat base (tarp removed and pea gravel spread to allow vegetation re-growth after work is complete). Power for transfer equipment will be either through use of the existing distribution lines at the camp or by gas-operated engines. Sample ore will be removed from the forest so that no milling facilities or support facilities for milling are needed.

#### G. Highway Impacts

Impacts on regional roads will be minimal during Phase 3 operations, with only minor impacts from long-haul trailer trucks. Three road features were identified as having the highest probability of impact from these operations: (a) 10-ton limit bridge approximately 1/4-mile north of the south boundary of the Ashley National Forest on the Moon Lake Recreational Road, (b) 3.5 miles of the same road, from the camp turnoff to Mountain Home, Utah, and (c) various cattle guard structures with estimated 10-ton load limits along this same road.

The referenced bridge has a small span, on the order of 20 feet between abutments. The 10-ton limit is based upon full vehicle load bearing within the supports at the same time (all wheel sets on the bridge simultaneously). Each axle of a long-haul 20 to 30 ton trailer truck supports 20% of the total load, or 4 to 6 tons per axle. From evaluation of equipment data and the maximum load criteria, no more than 2 axles with 5 tons maximum load on each may be on the bridge at

any single time. Loads on long-haul trailers will be limited to 25 tons for Phase 3 work to accommodate bridge limits.

Cattle guard structures are typically designed for axle loads ranging from 12 to 30 tons (AASHTO H-15 to H80). With the limits previously established, no more than 10 tons (two dual axles) could be on a cattle guard at any single time, less than the minimum design criteria for H-15 load, the smallest allowable cattle guard load.

It is anticipated that 64 long-haul trailer trips will occur during Phase 3 work over a 16-day period (3 to 4 large haul trucks per day), with 64 empty return trips. Based upon AASHTO methods for calculating highway loads, less than 100 18-kip Equivalent Single Axle Load (EASL) is expected from these activities. The Utah DOT was not able to provide any data on FS Development Road 131 and the county road section through to Mountain Home, Utah. Typical recreational roads are designed for 50,000 18-kip EASL's over a 20-year pavement life. With this assumption, Phase 3 traffic will reduce road life over this pavement section by about 2/10 of 1 percent. Impacts to more substantial paved highways from Mountain Home to the plant in Price, Utah will be even less. From previous conversations with the Utah Department of Transportation, no maintenance agreements are needed with agencies for these incidental road uses.

If required by the Forest Service, UMCC will enter into a road damage maintenance or compensation agreement on road sections controlled by the Forest Service that is consistent with methods used for other industries utilizing forest roads. It is understood that the USFS will provide the bond amount to UMCC prior to the start of work.

#### H. Water Quality Issues

Drainage water from storm runoff on the access road has been controlled by use of mud bars, road edge bar ditches, surface vegetation and natural cobble plating (see Figures I and J). These have been effective in providing a non-erosive surface. Specifically, water bars will be constructed as directed by the USFS to remove water to the outer edge of the road and prevent collection of storm waters at erosive sections. Low points and outflows that collect water will be protected with rip-rap rock to prevent erosion. At these locations, water will be allowed to cross through the rock drainage blanket, flowing under road beds. Filter fabric will cover the rock drain and a road bed will be reconstructed above (see Figure K).

Phase 3 activities should not impact the access road or increase sedimentation from this source. Minor road maintenance will be performed that includes removal of fallen trees from the road path (cut and place to the side of the road) and hand-removal of loose rocks from the surface from a road crew. Blading will only be done in any wash-outs. At this time, there has been only one reported washout on the 6.5 miles of road.

Test pits adjacent to the natural erosive talus slope and slide zone will be reclaimed and stabilized with terraced embankments and gabion rock walls that will slow storm water and snow melt runoff, inhibiting sedimentation.

With the inclusion of the planned additional control measures, sediment delivery from the reclaimed Phase 3 test pit will be minimal. The pit will capture most runoff and minor sediments that will develop during excavation and sampling operations. In the event that seasonal rains

result in sediment loss during the active operations, UMCC will employ the use of temporary silt fences, hay bales and terracing to capture sediments within roadway flows.

Completed reclamation is estimated to match sediment loss on the existing slope. Sediment calculations indicate that the cut slopes above the test pit will result in 85% of the total sediment from the project. 15% of the total sediment will derive from the lower reclaimed terrace slope. Re-vegetation with seeding alone will not be adequate to mitigate sediment loss on these surfaces. Additional measures such as placement of Excelsior blankets or wood fiber slurry on these surfaces will be required to produce sediment loss rates equal to the existing slope. Figure L shows the ratio of new to existing slope sediment loss over time.

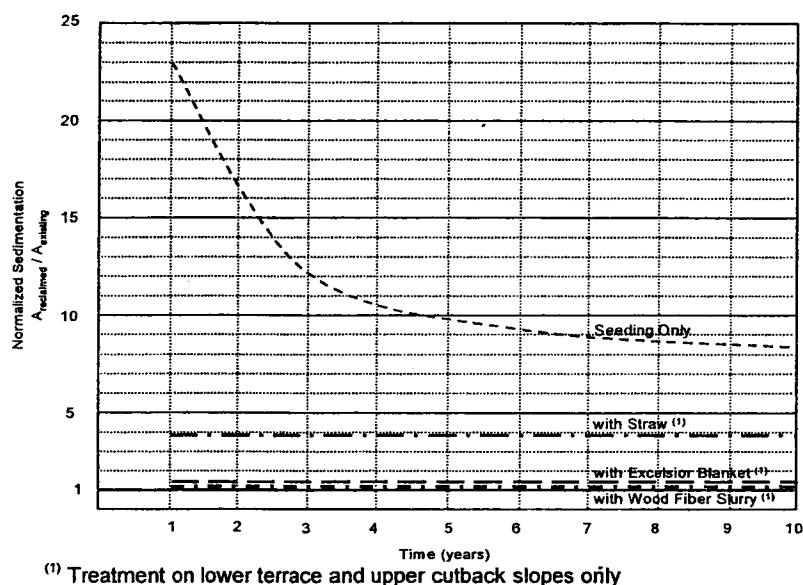


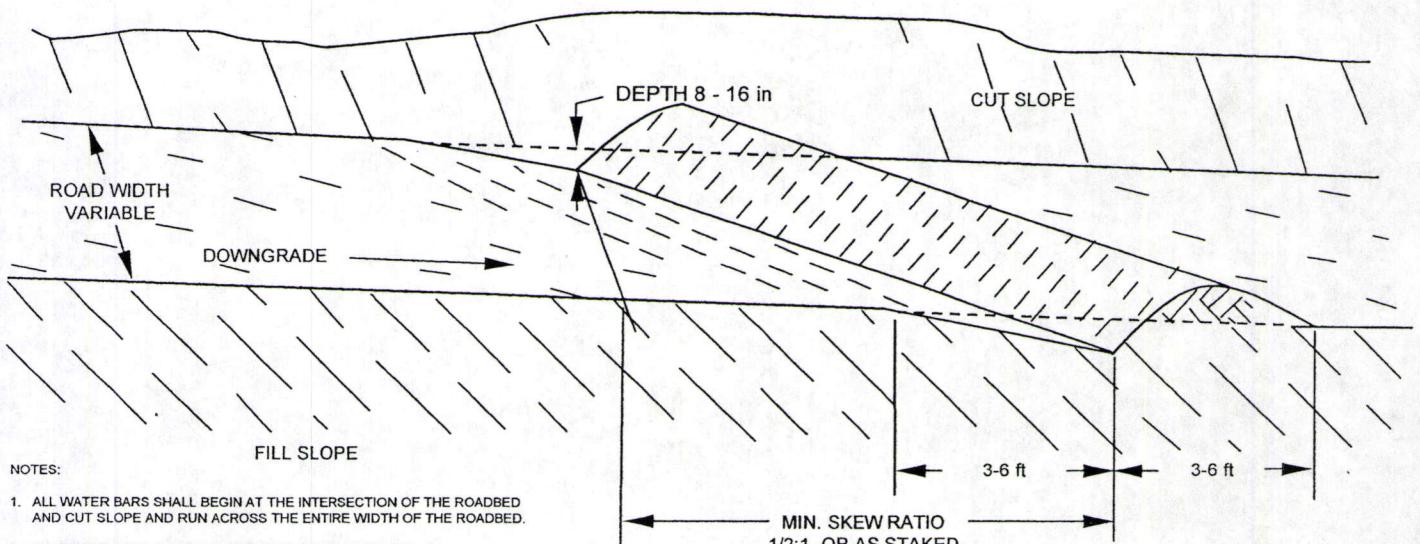
Figure L. Sediment Delivery from Phase 3 Test Pit Area after Reclamation

As noted in Section V (B) of the POO, minor water needed during the test pit work for road dust control would be obtained from off-forest water sources. 20 years of experience on the access road has shown that water for dust control is rarely needed. Water spraying would occur only during the 16 days of ore hauling. Minor traffic during other times would not generate appreciable dust. More than 80 percent of the access road is vegetated or naturally plated with rock, requiring no dust control under any condition. Under the worst case condition, a 5000 gallon water truck would need to fill up once ever other day for the 16 day haul period, or about 2500 gallons per day. The company will not obtain water rights for this work, but will require the contractor who performs the work to be responsible obtaining water and applying dust control measures.

## I. Security and Public Safety

Three existing gates on the access road can be used to limit public entry to the camp site, access road and test pit area. Closure of two of the three gates is at the discretion of the Forest Service. UMCC would recommend that all three be closed to public use during test pit activities for safety and security reasons. Since the road is generally not open for public use, this should not create an undue burden on the public.

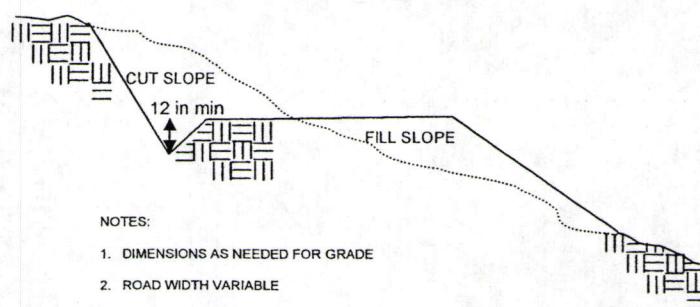
NO SCALE



**Figure I**

### Standard Detail For Water Bar

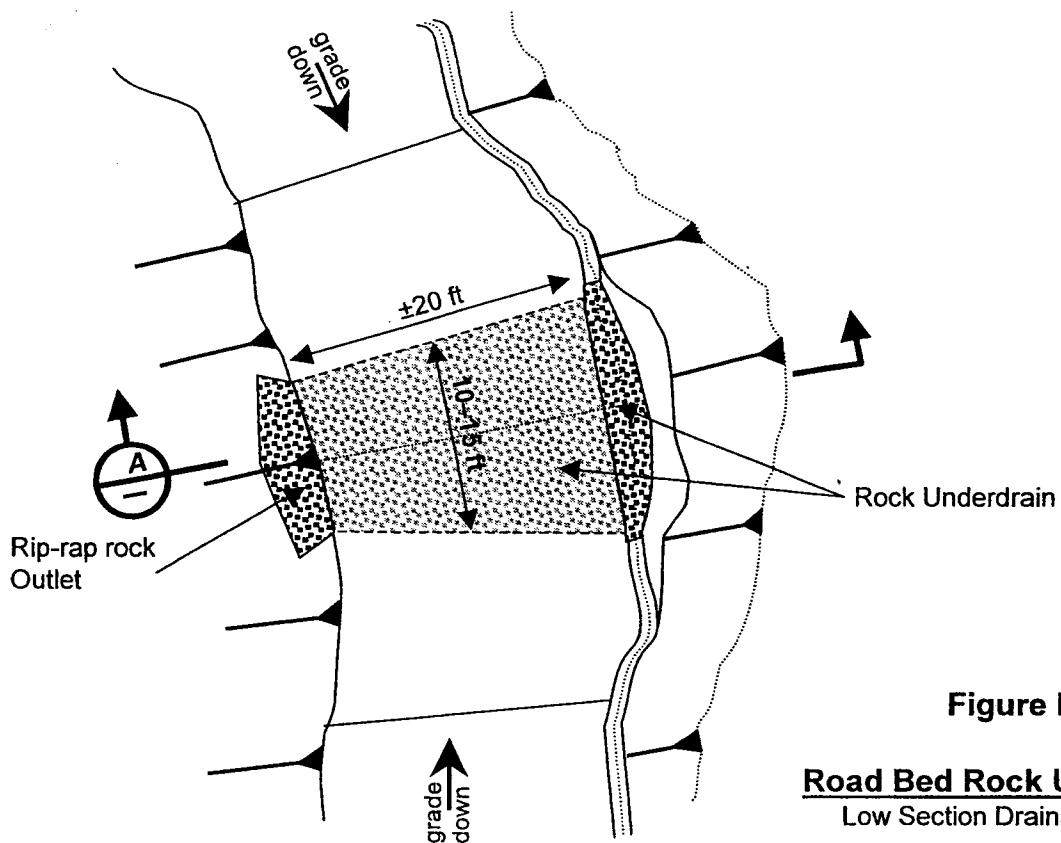
(adapted from USDA FS Wallowa-Whitman NF standards)



**Figure J**

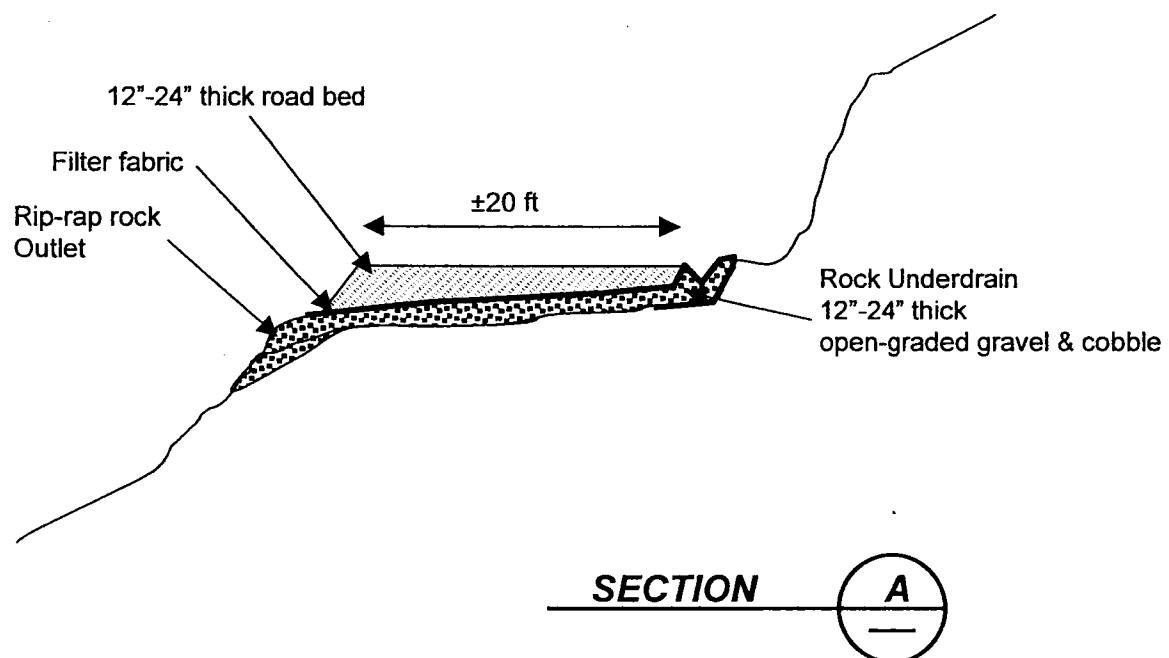
### Standard Road Cross Section W/ditch

(adapted from USDA FS Wallowa-Whitman NF standards)



**Figure K**

**Road Bed Rock Underdrain**  
Low Section Drainage (NTS)



**SECTION**



In terms of the camp site, closing of the lower gate at main road to Moon Lake (FS Development Road 131) will significantly restrict public access to all activities. For project safety, UMCC plans on maintaining one person at the camp site whenever equipment is present (primarily during sample ore haul/transfer work) and during test pit excavation/reclamation work.

The upper gate on the claims will remain open during haul operations, but the two lower gates can be locked (this will be up to the Forest Service since UMCC has no control over closure of these gates). The middle gate just above the camp site may be left unlocked during access road haul work since there will be a person at the camp to control egress. During overburden removal, stockpile and reclamation activities, the upper gate can also be locked to prevent public access. Truck drivers will also contact the camp site individual prior to leaving the ore transfer location for the camp site. It will be the responsibility of this person to warn access road travelers and truck drivers of the traffic conditions.

The volume of sample ore to be hauled is minor and will negligibly impact the public travel way. Only 3 to 4 haul trucks will enter the paved main road each day during the 16-day ore haul period, or about 1 truck every 2 hours. A few passenger vehicles will also enter once or twice a day during the remainder of the work. If requested by the Forest Service, UMCC will post appropriate signage at the intersection and require the camp site individual assigned to safety and security to act as a flagman when haul trucks enter the public travel way. If required, UMCC will widen the pavement at the intersection to provide safer access to the public travel way.

In terms of travel on county and state highways to the plant site in Price, Utah, all trucks will be hauling under legal weight limits and should pose no greater danger to the public than the present truck traffic that frequently use the same public roads (such as timber logging and coal haul trucks that consistently use these roads in Duchesne and Carbon Counties). Hauling will be contracted to a licensed trucking firm and drivers will be contractually obligated to comply with all Federal, State and Local traffic regulations.

#### J. Fuels and other Equipment-related Fluids

Other than fuel (diesel, gas) and other equipment operating fluids (hydraulic fluids, battery acid, brake fluid, transmission fluid) that are contained within normal vehicle and heavy equipment operating tanks, none of these materials will be stored at the camp site or mine area. Per 40 CFR 112, a spill prevention control and countermeasures plan (SPCC) is only required if total oil or oil products storage exceeds 1,320 gallons or if any single container exceeds a capacity of 660 gallons. No fuel or fluid containers of these volumes are needed or will be used for the test pit project.

To eliminate or minimize fuel and fluid spills, work vehicles and haul trucks will fuel at off-site commercial fueling stations prior to arrival the site for work each day or as needed to perform the work. Heavy equipment is to be fueled and serviced prior to site mobilization. Gas-powered conveyors will be fueled as needed via 5-gallon or smaller hand-operated fuel cans (not to be stored on site). Because of the limited time required for the test pit project, it is expected that heavy equipment will only need to be re-fueled once or twice at the test pit site. Typical fueling by the contractor is via sealed 55-gallon drums and hand-operated pumps. Heavy equipment that requires emergency on-site servicing (greasing or repair) will be done on level ground in an area pre-designated by the Forest Service. All other equipment servicing will be done at approved off-forest repair facilities.

UMCC will contractually obligate contractors to perform the following measures in the event of a fuel or fluid spill from vehicles or heavy equipment: (a) the contractor's superintendent will make a record of the type and volume of spill along with the location and date of occurrence, (b) all soil saturated by spilled fluids will be immediately excavated and stored for removal in 55-gallon drums (contractor will be required to keep at least 3 empty drums at the camp site and at the ore transfer site at all times), and (c) drums containing contaminated soil will be removed from the forest and disposed of in accordance with all Federal, State and Local regulations.

**K. Forest Fire Evacuation Plan**

UMCC desires to utilize evacuation plans already in place by the Forest Service for their personnel and the public at the Moon Lake Lodge (to be provided by the Forest Service). In addition, UMCC will take the actions identified in the following discussion to prepare for a possible forest fire.

Communication is the most effective method for providing early evacuation from a wildfire. All truck drivers on the access road and the superintendent at the test pit site will have mobile phones for contact. If mobile phones cannot reach all areas of work, then UMCC will obtain radios for on-site personnel.

UMCC will either assign an on-site individual as the contact person for the Forest Service or the contractor superintendent will act as the contact. The Forest Service will be given names and phone numbers at the start of work. The Forest Service will call the UMCC contact person in the event of a wildfire being reported in the area. This person will then contact all others at the site by either mobile phone or radio. All work will cease and personnel will report to the camp site as quickly as possible. Once all personnel are accounted for, the group will leave the forest as directed by the Forest Service.

The access road is the only safe escape route for vehicle travel. If an advancing wildfire is expected to block the access road prior to exit (vehicle travel takes about 45 minutes), then, upon notification of the Forest Service, all personnel shall be directed to move to a safety zone pre-designated by the Forest Service. This will be an area near the test pit site deemed safe by the Forest Service in terms of general topography and vegetation.

It should be noted that UMCC does not intend to perform work at the site in times of extreme fire danger because of liability issues associated with the potential for heavy equipment performing work to start a fire.

**L. References**

- A. R. Rodriguez, H. del Castillo and G. F. Sowers, "Soil Mechanics in Highway Engineering," 1988.
- P. M. Kandaris, "Use of Gabions for Localized Slope Stabilization in Difficult Terrain," Proceedings: 37<sup>th</sup> US Rock Mechanics Symposium, June 1999.
- Maccaferri Gabions, Inc., "Retaining Structures," 1995.

UMCC, "Addendum #1 to 1996 Revisions to Plan of Operations," response to USFS comments, May 21, 1996.

UMCC, "Slope Stability Analysis of Test Pit Phase III Work," response to comments by Richard Kennedy, June 3, 1999.

UMCC, "Clarifications to 1999 UMCC Plan of Operations," responses to USFS supplemental data request, November 30, 2000.

UMCC, "Response to Letter of 4/16/01 and Meeting of 5/10/01," May 14, 2001.

## Computation Sheet

BY PMK DATE 8/01 SUBJECT Slope Stability Analysis SHEET 1 OF 5  
 CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_ Sunshine/Hematite Claims Project – Test Pit \_\_\_\_\_ JOB NO. \_\_\_\_\_

1. Evaluate stability of existing slope, cut embankment for test pit and reclaimed test pit.
2. Methodology: Use Simplified Bishop method for determining failure surfaces by circular-arc method of slices. Use two-dimensional limit equilibrium methods. Apply methods that can analyze gabion basket walls and mechanically-stabilized earth with geotextiles (geogrids).

Computer analysis programs:

RSS (Reinforced Soil Slopes) The program is based on Federal Highway Administration manual "Reinforced Soil Structures Volume I-Design and Construction Guidelines" (FHWA-RD-89-043). This program analyzes and designs soil slopes strengthened with horizontal reinforcement, as well as analyzing unreinforced soil slopes. (an extensively modified version of the STABIL computer program and guidelines for design of soil reinforcements as stated in Elias and Christopher (1996) and Christopher et. al. (1989 and 1990)).

GAWAC R2.0 (Gabion Wall Calculations) A Bishop-Rankine limit equilibrium program created by Maccaferri Gabions, Inc. to allow design of flexible gabion wall structures.

### 3. Stability Criteria

Use Bowles (1996) recommendations for long and short term safety factors:

Long term:  $FS = 1.5$  to  $2.0$  (retaining walls, shear failures)

Temporary excavation:  $FS = 1.2$  to  $1.5$

Gabion Wall: Sliding:  $FS > 1.5$       Overturning:  $FS > 2.0$

Base Stability:  $FS > 1.5$

### 4. Soil Strata Properties

Material properties are to be derived from available bore log data, core laboratory tests, empirical field test data and published literature. An extensive discussion and development of these properties is attached and the results are summarized.

#### Existing Slope

Layer	Normal Unit Wt (pcf)	Sat Unit Wt (pcf)	Effective Friction Angle (degree)	Effective Cohesion (psf)
1. Unconsolidated Overburden	125	134	34	100
2. Fractured Rock (recovery < 80%)	137	141	38	400
3. Competent Rock (recovery > 80%)	152	155	38	2080

Backfill (consisting of a mix of overburden soils and fractured rock)

Normal Unit Wt (pcf)	Sat Unit Wt (pcf)	Effective Friction Angle (degree)	Effective Cohesion (psf)
138	140	38	10

# Computation Sheet

BY PMK DATE 8/01 SUBJECT Slope Stability Analysis SHEET 2 OF 5  
 CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_ Sunshine/Hematite Claims Project – Test Pit JOB NO. \_\_\_\_\_

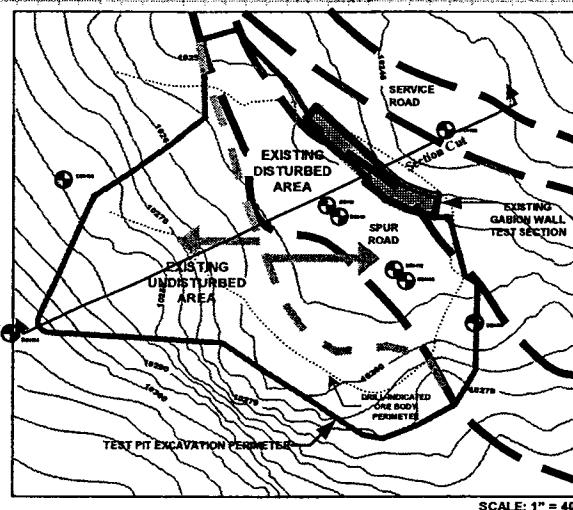
## Gabion Rock Fill

Normal Unit Wt. (pcf)	Effective Friction Angle (degree)	Effective Cohesion (psf)	Porosity (%)
155	38	0	20

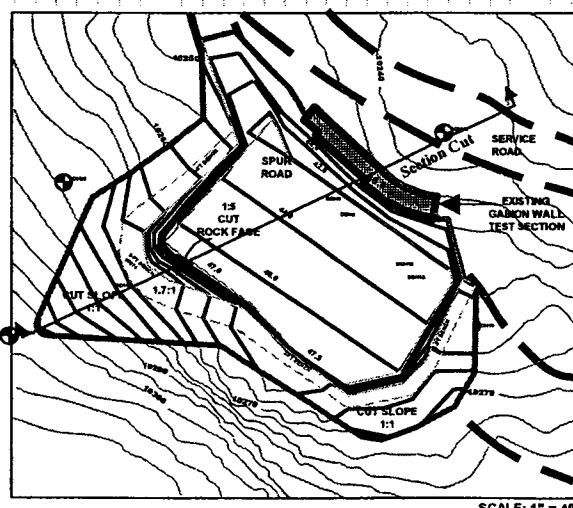
Note: Drainage rock will be the same as gabion rock fill, w/unit weight =  $155 \times 0.80 = 124$ pcf

## 5. Slope Geometry: Plans and Profiles

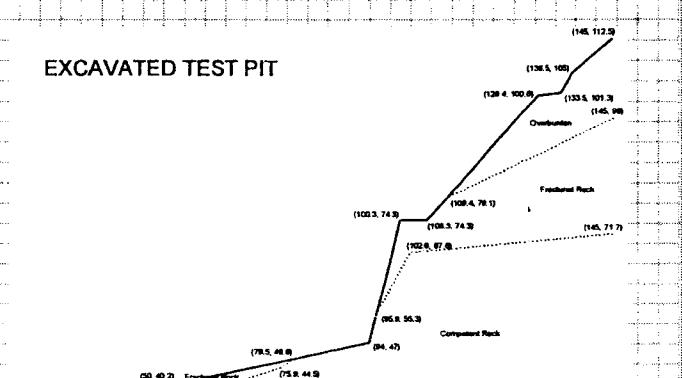
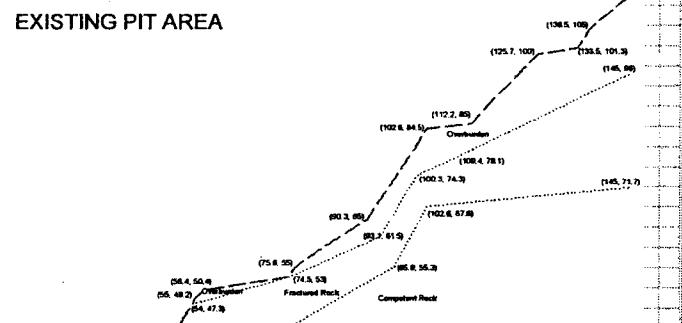
Pit cut slopes were reconfigured per discussions with Forest Service (May 2001). Slope stability cross section for this analysis was taken at the extreme ends of the pit where the deepest cut and the steepest slopes would be found. By inspection, all other cross sections would be more conservative and provide higher safety factors. The following sketches provide the plan and idealized profile of the existing slope, the test pit cut slope and the reclaimed hillside.



EXISTING PIT AREA

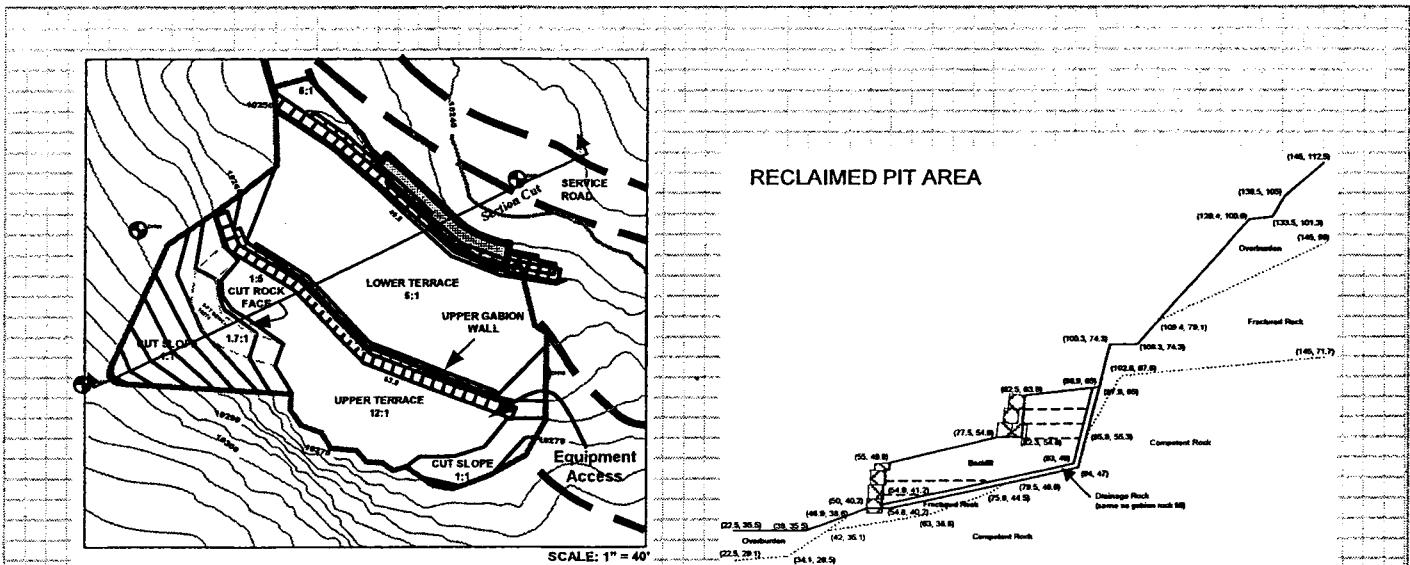


EXCAVATED TEST PIT



# Computation Sheet

BY PMK DATE 8/01 SUBJECT Slope Stability Analysis SHEET 3 OF 5  
 CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_ Sunshine/Hematite Claims Project – Test Pit \_\_\_\_\_ JOB NO. \_\_\_\_\_



## 6. Gabion Wall Stability Analysis

Backfill behind gabions is to be analyzed for the following cases:

- (a) backfill loads
- (b) compaction equipment loads on full backfill - edge of equipment at 2-ft from edge of gabions (CAT D8, with nearest tread 3-ft from back face of wall was assumed as the largest load possible for the planned work)
- (c) catchment above upper wall with surcharge load from overburden slope failure

The backfilled pit area will be evaluated with both soil reinforcement and no soil reinforcement at each gabion basket wall. Type of reinforcement chosen is Maccaferri Paragrid 50/15 (material property sheet is attached). Reinforcing layers are within the embankment at elevations 43.2 and 46.2 for the lower wall and at elevations 54.8, 57.8 and 60.8 for the upper wall.

Safety factor summary is shown below in tabular form (RS = Reinforced Soil):

Wall Case	Backfill Only		Backfill w/equipment Loads: <sup>(1)</sup>		Backfill with surcharge on catchment	
	w/out RS	W/RS	w/out RS	W/RS	w/out RS	W/RS
Lower Wall						
sliding	4.48	(2)	2.55			
overturning	2.66		<b>1.66</b> <sup>(3)</sup>			
base stability	2.02	2.41	1.45	1.80	—	—
Upper Wall						
sliding	negligible		5.17		7.03	
overturning	16.7		6.93		5.70	
base stability	1.59	2.50	1.21	1.68	<b>1.31</b>	2.04

(1) Considered a transient (temporary) load condition; lower safety factor acceptable

(2) Items left blank were non-applicable to the analysis method

(3) Items in bold indicate low safety factor

Note: Analyses indicate that the bearing pressure applied to the slope from the upper and lower gabion walls is 1500 psf and 900 psf, respectively. Use 1500 psf for overall slope stability analyses.

## Computation Sheet

BY PMK DATE 8/01 SUBJECT Slope Stability Analysis SHEET 4 OF 5  
 CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_ Sunshine/Hematite Claims Project – Test Pit \_\_\_\_\_ JOB NO. \_\_\_\_\_

### 7. Slope Stability Analysis

Slope stability analyses are required for the existing slope (baseline for comparison), the excavated test pit area, and the reclaimed test pit area. Cases to be evaluated include (a) deep-seated failure through the toe of the slope (between elevations 38 to 50) for all three conditions, (b) surface failure within weaker overburden (typically at or above the top of the test pit slope; above elevation 74.3) for all three conditions, and (c) backfill failure for the reclaimed test pit case.

The backfilled pit area will also be evaluated with soil reinforcement. Type of reinforcement chosen is Maccaferri Paragrid 50/15 (material property sheet is attached). Reinforcing layers are within the embankment at elevations 43.2 and 46.2' for the lower wall and at elevations 54.8, 57.8 and 60.8' for the upper wall.

All layers except the overburden material were assumed to be at normal moisture content for this analysis. Overburden was assumed to be saturated. Backfill was not analyzed as saturated because of the installation of the drainage layer. Effective cohesion and friction were used in stability analyses per the recommendations in the attached discussion section.

Safety factor summary is shown below in tabular form (RS = Reinforced Soil):

Condition	Surface Failure		Deep-Seated Failure		Backfill Failure	
	w/out RS	W/RS	w/out RS	W/RS	w/out RS	W/RS
Existing Slope	<b>1.28</b>	— <sup>(2)</sup>	1.82	—	—	—
Excavated Pit <sup>(1)</sup>	1.32	—	1.72	—	—	—
Reclaimed Pit	<b>1.32</b>	—	1.83	1.92	1.79	2.20

(1) Considered a transient (temporary) load condition, lower safety factor acceptable

(2) Items left blank were non-applicable to the analysis case

(3) Items in bold indicate low safety factor

### 8. Discussion and Conclusions

- Overall slope stability of reclaimed test pit area is equal to or slightly better than existing conditions. Potential for near surface slope failures remains high, but inclusion of catchment in reclaimed gabion design prevents loss of material downhill. Potential for deep seated failure decreases with inclusion of soil reinforcement (factor of safety increases from 1.82 to 1.92).
- Use of soil reinforcement allows for safer construction and long-term stability of gabion wall embankments. Base stability of the lower and upper walls increases during and after installation when using soil reinforcement 19-24 percent and 38-57 percent, respectively. Overall backfill stability increases 23 percent.
- Slope stability safety factor for the revised excavated test pit area is acceptable for short term conditions.
- To prevent possible overturning failure, heavy earthmoving equipment should not be placed within 10 feet of the edge of the lower gabion wall once fill has been placed to the final elevation. Lighter equipment should be used for final lift compaction.

## Computation Sheet

BY PMK DATE 8/01 SUBJECT Slope Stability Analysis SHEET 5 OF 5  
CHKD. BY   DATE   Sunshine/Hematite Claims Project – Test Pit JOB NO.  

- The upper gabion wall (w/soil reinforcement) can safely support potential overburden soil failures from slopes above the test pit area.

### 9. References

Bowles, J. E. (1996) *Foundation Analysis and Design*, 5<sup>th</sup> Ed., McGraw-Hill, New York.

Christopher, B. R., Gill, S. A., Giroud, G. P., Juran, I., Mitchell, J. K., Schlosser, R. and Dunnicliif, J. (1989) "Reinforced Soil Structures; Design and Construction Guidelines," Volume 1, FHWA Report No. FHWA-SA-89-043.

Christopher, B. R., Gill, S. A., Juran, I., and Mitchell, J. K. (1990) "Summary of Research Systems Information," Volume 2, FHWA Report No. FHWA-RD-89-044.

Elias, V. and Christopher, B. R. (1996) "Mechanically Stabilized Earth Walls and Reinforced Soil Slopes; Design and Construction Guidelines," FHWA Report No. FHWA-SA-96-071.

## A. Material Properties

1. Available Data: (1) core logs from 1994-95 drilling, (2) rock core tests, (3) 1997 test pit program

Core log: Borings DDH 8, 9, 14 and 25 are from the test pit area (Wall, 1996; summary is attached).

Rock Cores: 45 cores of low-grade iron oxide content overburden rock were tested to determine specific gravity (Wall, 1996; summary is attached).

Test Pit: Field measures of weights and volumes of ore and overburden (report previously provided).

2. Unit Weight Analyses

Overburden Rock – Rock core tests with iron oxide contents ranging from 0.53% to 21.2% provided an average specific gravity of 2.525, or a total unit weight of 157.6 pcf. This material is representative of overburden rock that would remain after removal of marketable iron oxide ore.

Overburden Soil – Described in bore logs as a clayey gravel with sand. 1997 test pit work estimated this material after excavation (loose) to weight approximately 103 pcf. With a 20% swell factor (Merritt, 1983: earth/loam = 25%, gravel = 12%), the in-bank total unit weight estimate becomes 124 pcf. Published references for clayey gravel (Hunt, 1984 & NAVFAC, 1971) recommend a typical total unit weight range of 125 to 135 pcf. For this analysis, use  $\gamma_t = 125$  pcf at 10% moisture (Hunt, 1984: moisture content for GC ranges from 9-14%).

Strata – From core logs, the following properties were obtained. Core recovery is directly correlated with rock content for the purpose of unit weight analysis (i.e.: 100% recovery = 100% overburden rock, 0% recovery = 100% overburden soil). Moisture contents are visual estimated during field work.

Strata	Core Data		Moisture Estimates		Overburden Distribution		Unit Weight (pcf)	
	RQD	% Recovery	% insitu	% @ saturation <sup>(1)</sup>	% soil	% rock	total	saturated
Overburden soil	0	0	10	17.5	100	0	125	134
Limestone OB and upper strata TBS	<25	15 - 60	8	10.5	63	37	137	141
Lower strata TBS	25-50	85 - 100	4	6	15	85	152	155

<sup>(1)</sup> USBR (1974) nomograph for calculating saturation moisture content:  $G_s = 2.65, 2.60, 2.53$  for overburden soil, LS/upper TBS, lower TBS, respectively.

Backfill - From review of the cross section at the proposed pit location, each strata incorporates approximately 1/3 of the total volume of overburden after removal of iron oxide ore. Therefore, the average total unit weight of overburden = 138 pcf and the average saturated unit weight of overburden = 143 pcf. This material would be classified as a poorly graded clayey gravel/cobble. The literature (Rodriguez, Castillo & Sowers, 1988) notes similar material compacted to 100% of Standard Proctor density with a total unit weight of 135 pcf ( $\gamma_d = 120$  pcf at 12% moisture). Use a compacted unit weight of 138 pcf at 12% moisture content. Per USBR nomograph, saturated unit weight = 140 pcf.

Gabion Material – Screened overburden rock (+95%) will be used for gabion fill. The rock is highly fractured (100% 3 fractured faces) and packs densely into gabion baskets. Per lab tests, rock unit weight = 156.7 pcf. At 95% overburden rock and 5% overburden soil, the total unit weight of gabion fill = 155 pcf.

Gabion basket porosity – Per lab tests and MacCaferrri catalog, 3"-8" rounded "river-run" fill rock has a porosity from 30-40%. Additional lab tests on 1"-1.5" rounded gravels notes a porosity of 35-30%. Hunt (1984) reports void ratios for well graded gravels of approximately 22%. Highly fractured 3"-12" limestone should have a porosity less than those noted above, or from 15-20%. For this analysis, 20% will be used.

### 3. Strength Properties

Overburden Soil – From review of core logs and site experience, the overburden soils clearly contain a significant clay component. Use of both strength properties is common for calcareous deposits (and is recommended by Rodriguez, Castillo & Sowers, 1988, for cuts and natural slopes with slightly overconsolidated conditions). Minimum values of cohesion and internal friction angle in the literature for residual limestone clayey gravel are typically 100 psf and > 31 degrees, respectively (Siegle & Belgeri, 1999; Hunt, 1984). Increase internal friction angle by 10% for substantial particle angularity, or use 34 degrees.

Overburden Rock – Rock mass strength can be determined using rock mass property analysis methods provided by Hoek (1994) and Hoek-Brown (1988). Hoek's rock mass rating method uses the concept of the Geologic Strength Index (GSI) and is based upon Bieniawsk's first four Rock Mass Rating (RMR, 1976) class rating items of core rock strength, RQD, joint spacing and joint condition. The Hoek-Brown method of rock mass strength analysis is a Mohr-Colomb method with a direct output of equivalent cohesion and friction values. The analytical summary is attached. The following table provides a summary of analysis results and properties assumed for the slope stability analyses.

Strata	Core Data		Hoek-Brown strength values		Strength values for this analysis <sup>(1)</sup>	
	RQD	% Recovery	cohesion, psf	friction angle, deg	cohesion, psf	friction angle, deg
Limestone OB and upper strata TBS	<25	<80%	600	56	400	38
Lower strata TBS	25-50	>80%	3110	56	2080	38

<sup>(1)</sup> Standard practice is to use 2/3 value of Mohr-Colomb estimates for analysis.

Backfill – Compacted backfill can be viewed either as a rockfill with a significant clay component or a clayey gravel with a significant cobble component. With either scenario, cohesion should be held to a minimum value. Based upon evaluation of overburden soils, cohesion should be somewhat less than 100 psf but definitely greater than zero. For the purposes of this analysis a highly conservative value of 10 psf is used. Beckwith & Hirany (1991) provide friction angle values for various rockfills. Assuming an average normal stress of 20 psi ( $\gamma_t = 130$  pcf at 20-ft cut depth - see the attached chart), the low bound for a poorly graded, low density, weak particle rock fill is given at 42.5 degrees. Hunt (1994) notes the minimum friction angle for a poorly graded compacted gravel (with or without clay) to be >37 degrees. Use 38 degrees for this analysis.

## B. Rock & Soil Properties Used in Analyses

### Existing Slope

Layer	Normal Unit Wt (pcf)	Sat Unit Wt (pcf)	Effective Friction Angle (degree)	Effective Cohesion (psf)
1. Unconsolidated Overburden	125	134	34	100
2. Fractured Rock (recovery < 80%)	137	141	38	400
3. Competent Rock (recovery > 80%)	152	155	38	2080

Backfill (consisting of a mix of overburden soils and fractured rock), layer 4

Normal Unit Wt (pcf)	Sat Unit Wt (pcf)	Effective Friction Angle (degree)	Effective Cohesion (psf)
138	140	38	10

### Gabion Rock Fill

Normal Unit Wt (pcf)	Effective Friction Angle (degree)	Effective Cohesion (psf)	Porosity (%)
155	38	0	20

## C. References

Beckwith, G. H. and Hirany, A. (1991) "Design and Construction of Drilled Shafts in Coarse Gravel and Cobble Deposits," Piling and Deep Foundations, Proceedings: 4<sup>th</sup> International Conference on Piling and Deep Foundations, April 7-12, Stresa.

Bieniawski, Z. T. and Orr, C. M. (1976) "Rapid Site appraisal for Dam Foundation Classification by the Geomechanical Classification," Transactions: 12<sup>th</sup> International Congress on Large Dams, Vol. 3, Mexico City.

Hunt, R. E. (1984) Geotechnical Engineering Investigation Manual, McGraw-Hill, New York.

Hoek, E. (1994) "Strength of Rock and Rock Masses," *ISRM News Journal*, Vol. 2, No. 2.

Hoek, E. and Brown, E. T. (1988) "The Hoek-Brown Failure Criterion – a 1988 Update," Proceedings: 15<sup>th</sup> Canadian Rock Mechanics Symposium, October 3-4, Toronto.

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Merritt, F. S. (1983) *Standard Handbook for Civil Engineers*, 3<sup>rd</sup> Ed., McGraw-Hill, New York.

Naval Facilities Engineering Command (1971) "Design Manual Soil Mechanics, Foundations, and Earth Structures," NAVFAC DM7, US Naval Publications and Forms Center, Philadelphia.

- Rodriguez, A. R., del Castillo, H., and Sowers, G. F. (1988) *Soil Mechanics in Highway Engineering*, Trans Tech Publishing, Clausthal-Zellerfeld.
- Siegel, T. C. and Belgeri, J. J. (1999) "Grouting to Reinforce Limestone Residual Soils in East Tennessee," *Behavioral Characteristics of Residual Soils*, Proceedings of Sessions of Geo-Congress '99, Geotechnical Special Publication #92, October 17-20, Charlotte, North Carolina.
- US Bureau of Reclamation (1974) *Earth Manual*, USBR, Denver.
- Wall, L. L. (1996) "Summary Geological Report: Uintah Mountain Copper Company Sunshine Quartz/Hematite Project," internal company report.

Iron Oxide Content (%) Specific Gravity

0.53	2.50		
0.67	2.50		
0.64	2.67		
7.45	2.67		
6.03	2.50		
0.97	2.50		
4.30	2.50		
6.57	2.50		
4.47	2.67		
6.00	2.50		
3.34	2.50		
20.60	2.67		
7.09	2.50		
2.75	2.50		
1.11	2.67		
1.07	2.35		
2.86	2.50		
21.20	2.50		
16.90	2.50		
2.31	2.67		
3.49	2.50		
4.44	2.67		
18.80	2.67		
3.28	2.50		
1.70	2.50		
2.51	2.35		
2.79	2.35		
2.18	2.35		
4.13	2.35		
3.78	2.50		
6.41	2.50		
12.40	2.50		
9.94	2.50		
9.72	2.67		
2.14	2.67		
1.92	2.50		
1.62	2.50		
3.96	2.50		
8.89	2.67		
9.03	2.67		
6.70	2.50		
1.51	2.50		
1.13	2.35		
1.72	2.50		
3.03	2.50		
Unit Weight			
Average	5.42	2.525	157.6

Boring/Depth	Description	%R <sub>ec</sub>	%RQD	Joint Spacing	Joint Condition
DDH14					
0'-10.7'	Overburden, primarily a clayey gravel w/sand	0	0	n/a	n/a
10.7'-30.7'	Limestone, grey to tan sandy limestone to calcareous siltstone, zones of solution cavities and collapsed breccia filled w/sand & cemented sand, clay breccia zones	24-100	<25	20-300 mm	highly variable
30.7'-57.5'	Thinly Bedded LS Series, fine grained sandy LS and calcareous siltstone w/occasional sandy LS, minor brecciation	90-100	25-50	20-300 mm	highly variable, siliceous interbeds
DDH25					
0'-9'	Overburden, primarily a clayey gravel w/sand	0	0	n/a	n/a
9'-16.7'	Thinly Bedded LS Series, med-fine grained sandy and silty LS and calcareous siltstone, limonite & hematite clays present (montmorillonite), numerous clays seams and clay breccia	17-58	<25	20-300 mm	fractured coatings common, slip surfaces and crushed zones
16.7'-34.8'					
DDH 8 & 9					
0'-0.9'	Overburden, primarily a clayey gravel w/sand	0	0	n/a	n/a
0.9'-12.7'	Thinly Bedded LS Series, med-fine grained sandy and silty LS and calcareous siltstone, limonite & hematite clays present (montmorillonite), numerous clays seams and clay breccia	27-100	<25	20-300 mm	fractured coatings common, slip surfaces and crushed zones

Merritt, F.S., "Handbook for CE" (1983)

SCRAPER PRODUCTION 13-17

ion Factors\*

ion factors	
res	Tracks
0.45	
0.90	
0.70	
0.70	
0.30	
0.55	
0.50	
0.25	
0.12	
0.90	
0.60	
0.60	

Voids, %	Load factor
5	0.95
10	0.90
15	0.85
20	0.80
25	0.75
30	0.70
35	0.65
40	0.60
45	0.55
50	0.50

(13-7)

b. divided by density of the

TABLE 13-10 Percentage Swell and Load Factors of Materials

Material	Swell, %	Load factor
Cinders	45	0.69
Clay:		
Dry	40	0.72
Wet	40	0.72
Clay and gravel:		
Dry	40	0.72
Wet	40	0.72
Coal, anthracite	35	0.74
Coal, bituminous	35	0.74
Earth, loam:		
Dry	25	0.80
Wet	25	0.80
Gravel:		
Dry	12	0.89
Wet	12	0.89
Gypsum	74	0.57
Hardpan	50	0.67
Limestone	67	0.60
Rock, well blasted	65	0.60
Sand:		
Dry	12	0.89
Wet	12	0.89
Sandstone	54	0.65
Shale and soft rock	65	0.60
Slag, bank	23	0.81
Slate	65	0.60
Traprock	65	0.61

### 13-10. Scraper Production

Production is measured in terms of tons or bank cubic yards of material a machine excavates and discharges, under given job conditions, in 1 hour.

$$\text{Production, bank yd}^3/\text{h} = \text{load, yd}^3 \times \text{trips per hour} \quad (13-8)$$

$$\text{Trips per hour} = \frac{\text{working min/h}}{\text{cycle time, min}} \quad (13-9)$$

The load, or amount of material a machine carries, can be determined by weighing or estimating the volume. Payload estimating involves determination of the bank cubic yards being carried, whereas the excavated material expands when loaded into the machine. For determination of bank cubic yards from loose volume, the amount of swell or the load factor must be known (Tables 13-9 and 13-10); then the conversion can be made by use of Eq. (13-6).

Weighing is the most accurate method of determining the actual load. This is normally done by weighing one wheel or axle at a time with portable scales, adding the wheel or axle weights, and subtracting the weight empty. To reduce error, the machine should be relatively level. Enough loads should be weighed to provide a good average.

$$\text{Bank yd}^3 = \frac{\text{weight of load, lb}}{\text{density of material, lb/bank yd}^3} \quad (13-10)$$

For Eq. (13-9), cycle time, the time to complete one round trip, may be measured with a stopwatch. Usually, an average of several complete cycles is taken. Sometimes, additional infor-

TABLE 3.31  
TYPICAL PROPERTIES OF COMPACTED SOILS\*

Group symbol	Soil type	Typical value of compression		Typical strength characteristics				Typical coefficient of permeability, ft/min	Range of CBR values	Range of subgrade modulus, k <sub>s</sub> , lb/in
		Percent of original height	Range of optimum moisture, %	A1 1.4 (sf [20 psf])	A1 3.6 (sf [50 compacted psf])	Cohesion (as saturated), psf	Effective stress envelope, degrees φ, degrees			
GW	Well-graded clean gravels, gravel-sand mixtures	125-135	11-8	0.3	0.6	0	0	>38	>0.79	5 × 10 <sup>-2</sup> 40-80 300-500
GP	Poorly graded clean gravels, gravel-sand mix	115-125	14-11	0.4	0.9	0	0	>37	>0.74	10 <sup>-1</sup> 30-60 250-400
GM	Silty gravels, poorly graded gravel-sand silt	120-135	12-8	0.5	1.1	...	...	>34	>0.67	>10 <sup>-6</sup> 20-60 100-400
GC	Clayey gravels, poorly graded gravel-sand-clay	115-130	14-9	0.7	1.6	...	...	>31	>0.60	>10 <sup>-7</sup> 20-40 100-300
SW	Well-graded clean sands, gravelly sands	110-130	16-9	0.6	1.2	0	0	38	0.79	>10 <sup>-3</sup> 20-40 200-300
SP	Poorly-graded clean sands, sand-gravel mix	100-120	21-12	0.8	1.4	0	0	37	0.74	>10 <sup>-3</sup> 10-40 200-300
SM	Silty sands, poorly graded sand-silt mix	110-125	18-11	0.8	1.6	1050	420	34	0.67	5 × 10 <sup>-5</sup> 10-40 100-300
SM-SC	Sand-silt clay mix with slightly plastic fines	110-130	15-11	0.8	1.4	1050	300	33	0.66	2 × 10 <sup>-8</sup> ...
SC	Clayey sands, poorly graded sand-clay mix	105-125	19-11	1.1	2.2	1550	230	31	0.60	5 × 10 <sup>-7</sup> 5-20 100-300
ML	Inorganic silts and clayey silts	95-120	24-12	0.9	1.7	1400	190	32	0.62	10 <sup>-6</sup> 15 or less 100-200
ML-CL	Mixture of inorganic silt and clay	100-120	22-12	1.0	2.2	1350	400	32	0.62	5 × 10 <sup>-7</sup> ...
CL	Inorganic clays of low to medium plasticity	95-120	24-12	1.3	2.5	1800	270	28	0.54	10 <sup>-7</sup> 15 or less 50-200
OL	Organic silts and silt-clays, low plasticity	80-100	33-21	...	...	...	...	...	...	... 5 or less 50-100
MII	Inorganic clayey silts, elastic silts	70-95	40-24	2.0	3.8	1500	420	25	0.47	5 × 10 <sup>-7</sup> 10 or less 50-100
CI	Inorganic clays of high plasticity	75-105	36-19	2.6	3.9	2150	230	19	0.36	10 <sup>-7</sup> 15 or less 50-150
OII	Organic clays and silty clays	65-100	45-21	...	...	...	...	...	...	... 5 or less 25-100

\*From NAVFAC Manual DM 7 (1977). All properties are for condition of "standard Proctor" maximum density, except values of k and CBR which are for "modified Proctor" maximum density. Typical strength characteristics are for effective strength envelopes and are obtained from USBR data. Compression values are for vertical loading with complete lateral confinement. (...) Indicates insufficient data available for an estimate.

3.5 DEF  
3.5.1 INTL.  
Form  
Idea  
ELAS-  
tioni-  
mati-  
PLAS-  
ous,  
reac-  
Geo-  
mod-  
VISC-  
rou-

$$\gamma_d = 1157 \text{ lb/in}^3$$

$$w = 10\%$$

$$\gamma_1 = 1265 \text{ lb/in}^3$$

Ge-  
De-  
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the  
of  
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the

## TYPICAL PROPERTIES OF COMPACTED SOILS

Group symbol	Soil type	Range of maximum dry unit weight, psf	Range of optimum moisture, percent	Typical value of compression		Typical strength characteristics			Typical coefficient of permeability ft./min.	Range of CBR values	Range of subgrade modulus k lb/cu in.
				At 1.4 1sf (20 psi)	At 3.6 1sf (50 psi)	Cohesion (as compacted) psf	$\phi$ (Effective stress envelope) degrees	Tan $\phi$			
GW	Well graded clean gravels, gravel-sand mixtures.	125 - 135	11 - 8	0.3	0.6	0	>38	>0.79	$5 \times 10^{-2}$	40 - 80	300 - 500
GP	Poorly graded clean gravels, gravel-sand mix.	115 - 125	14 - 11	0.4	0.9	0	>37	>0.74	$10^{-1}$	30 - 60	250 - 400
GM	Silty gravels, poorly graded gravel-sand-silt.	120 - 135	12 - 8	0.5	1.1	.....	.....	>34	>0.67	20 - 60	100 - 400
GC	Clayey gravels, poorly graded gravel-sand-clay.	115 - 130	14 - 9	0.7	1.6	.....	.....	>31	>0.60	$10^{-7}$	20 - 40
SW	Well graded clean sands, gravelly sands.	110 - 130	16 - 9	0.6	1.2	0	0	38	0.79	$10^{-3}$	20 - 40
SP	Poorly graded clean sands, sand-gravel mix.	100 - 120	21 - 12	0.8	1.4	0	0	37	0.74	$10^{-3}$	200 - 300
SM	Silty sands, poorly graded sand-silt mix.	110 - 125	16 - 11	0.8	1.6	1050	420	34	0.67	$5 \times 10^{-5}$	10 - 40
SM-SC	Sands-silt clay mix with slightly plastic fines.	110 - 130	15 - 11	0.8	1.4	1050	300	33	0.66	$2 \times 10^{-6}$	.....
SC	Clayey sands, poorly graded sand-clay mix.	105 - 125	19 - 11	1.1	2.2	1550	230	31	0.60	$5 \times 10^{-7}$	5 - 20
ML	Inorganic silts and clayey silts.	95 - 120	24 - 12	0.9	1.7	1400	190	32	0.62	$10^{-5}$	15 or less
ML-CL	Mixture of inorganic silt and clay.	100 - 120	22 - 12	1.0	2.2	1350	460	32	0.62	$5 \times 10^{-7}$	.....
CL	Inorganic clays of low to med. plasticity.	95 - 120	24 - 12	1.3	2.5	1800	270	28	0.54	$10^{-7}$	15 or less
OL	Organic silts and silt-clays, low plasticity.	80 - 100	33 - 21	.....	.....	.....	.....	.....	.....	5 or less	50 - 300
MH	Inorganic clayey silts, elastic silts.	70 - 95	40 - 24	2.0	3.8	1500 ~	420	25	0.47	$5 \times 10^{-7}$	10 or less
CH	Inorganic clays of high plasticity.	75 - 105	36 - 19	2.6	3.9	2150	230	19	0.35	$10^{-7}$	50 - 100
OH	Organic clays and silty clays ...	65 - 100	45 - 21	.....	.....	.....	.....	.....	.....	5 or less	50 - 150

Notes:

- All properties are for condition of "standard Proctor" maximum density, except values of k and CBR which are for "modified Proctor" maximum density.
- Typical strength characteristics are for effective strength envelopes and are obtained from USBR data.

- Compression values are for vertical loading with complete lateral confinement.
- (>) indicates that typical property is greater than the value shown.
- (...) indicates insufficient data available for an estimate.

C1-10

Naval Facilities Engineering Command, "NAVFAC Manual DM7, March 1971, pg 7-9-2, Table 9-1

SOURCE:

SALT RIVER PROJECT  
STRUCTURAL-ARCHITECTURAL  
ENGINEERING

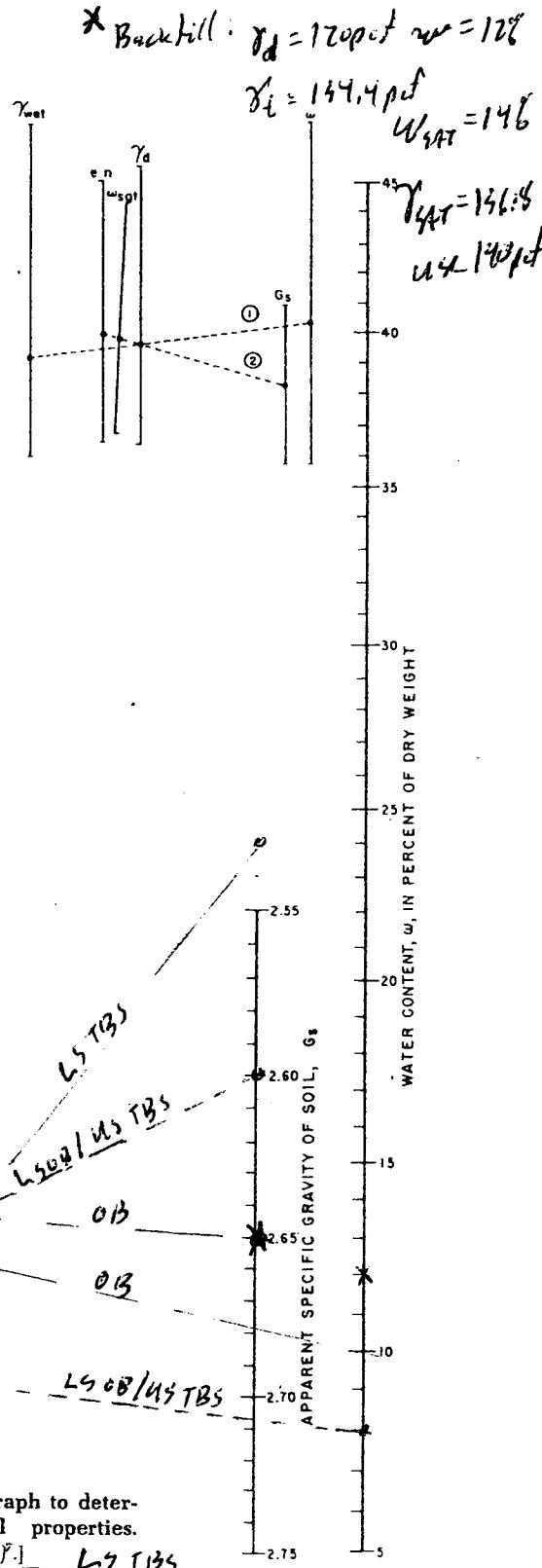
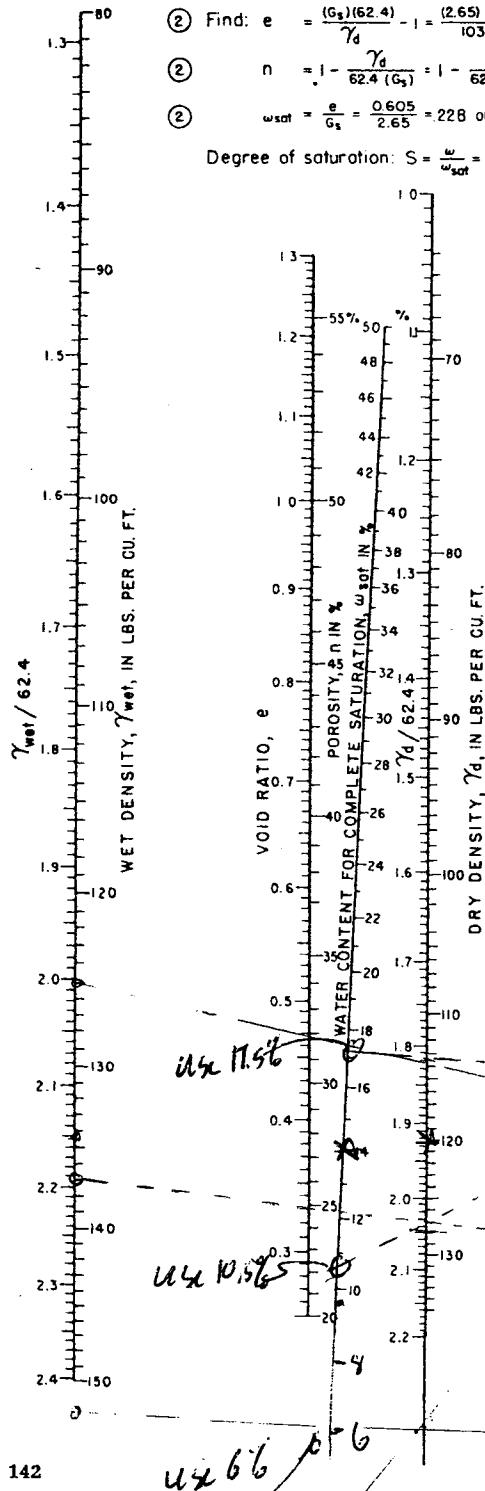


FIG. 3  
in situ  
airfield

FIG. 3.2 Nomograph to determine basic soil properties.  
[From USBR (1974).]

## BEHAVIORAL CHARACTERISTICS OF RESIDUAL SOILS

Grouting to Reinforce Limestone Residual Soils

East Tennessee - Siegler, T.C. &amp; Belgeri, J.S.

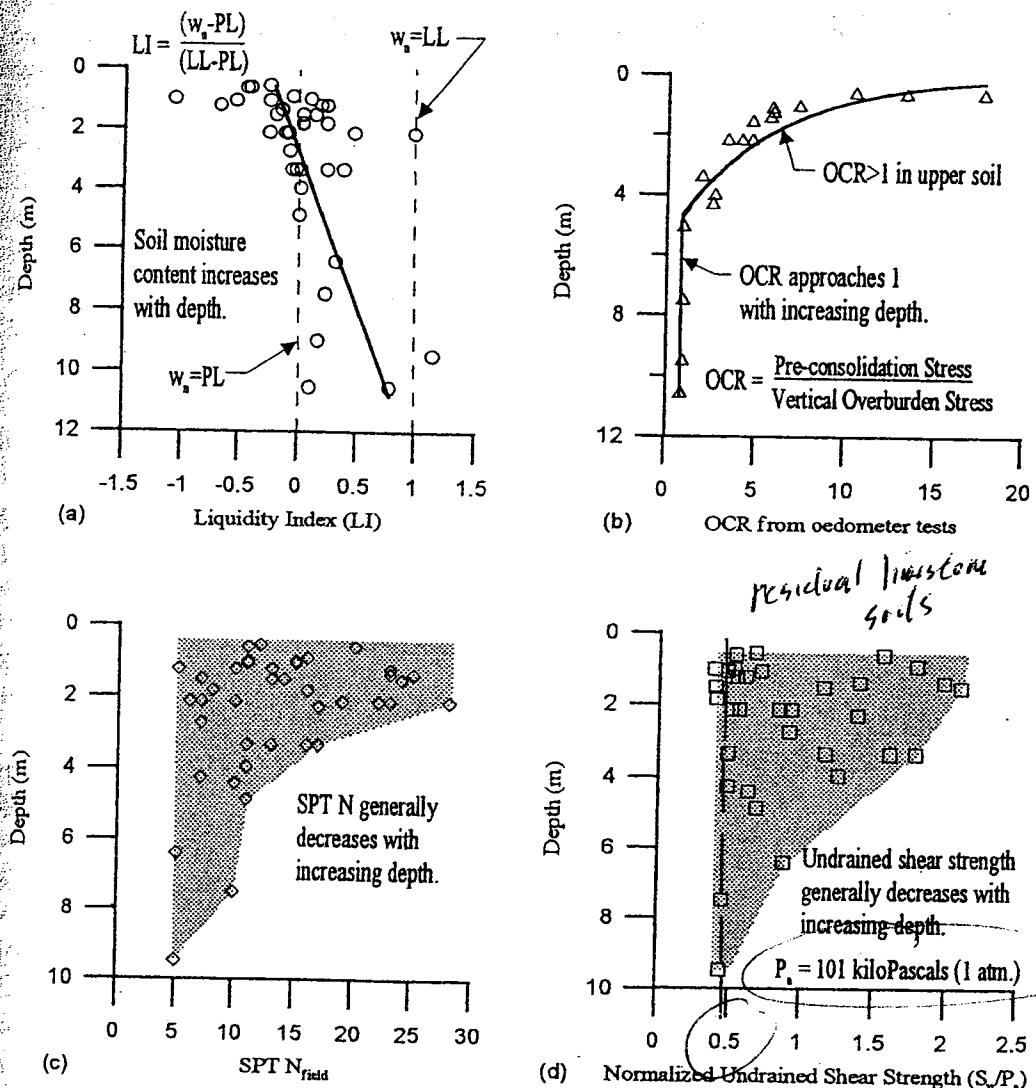


Figure 2. Field and Laboratory Test Results for Residual Soils from East Tennessee Karst: (a) Liquidity Index; (b) Over-consolidation Ratio; (c) Standard Penetration Test; (d) Undrained Shear Strength.

$$\underline{\underline{C = 100 \text{ psf}}}$$

\* Similar genesis to dolina formation, high iron oxide content / limestone, calcareous

Strata	%RQD	Joint Spacing	Joint Surfaces
Overburden	n/a	n/a	n/a
Limestone, TBS, recovery <80%	<25	primarily <50 mm	Rough, breccia, sol'n cavities, some clay/soft gouge
TBS, recovery >80%	25-50	primarily 50-300 mm	Coated, slick surfaces, hematite w/soft gouge

LS Core Characteristics:  
 Avg specific gravity of LS w/ 20% or less hematite content = 2.53 (unit wt. = 157.6 pcf)  
 (laboratory test results on 30 core samples)

Unconfined compressive strength of intact rock:  
 Fine grained limestone, conglomerates, cemented breccia of comparable  
 unit weights = 5 - 15 ksi (35 - 100 MPa)  
 (Hunt, 1984)

#### Rock Mass Strength (Hoek, 1994)    Method utilizes Geologic Strength Index (GSI)

1. Use first four Rock Mass Rating (RMR) class ratings (Bieniawski, 1976):

Strata	Parameter	No.	Description
Limestone, TBS, recovery <80%	R <sub>1</sub>	4	(unconfined compressive strength of intact rock specimen 3.6 to 7.2 ksi)
	R <sub>2</sub>	3	(RQD < 25%)
	R <sub>3</sub>	5	(joint spacing < 50 mm)
	R <sub>4</sub>	5	(joint condition: continuous joints, open 1-5 mm some soft gouge)
RMR partial rating, Strata 1 =		17	
TBS, recovery >80%	R <sub>1</sub>	4	(unconfined compressive strength of intact rock specimen 3.6 to 7.2 ksi)
	R <sub>2</sub>	8	(RQD 25% to 50%)
	R <sub>3</sub>	10	(joint spacing 50 to 300 mm)
	R <sub>4</sub>	5	(joint condition: continuous joints, open 1-5 mm some soft gouge)
RMR partial rating, Strata 2 =		27	

2. Per Hoek's recommendation, use RMR<sub>dry</sub> and favorable joint orientation for GSI determination - add 10 points to each rating

$$\begin{aligned} \text{GSI}_{\text{strata } 1} &= 27 && (\text{round down to 25}) \\ \text{GSI}_{\text{strata } 2} &= 37 && (\text{round down to 35}) \end{aligned}$$

3. Determine constant m<sub>i</sub> for both rock masses - based on rock type and texture - use Hoek's chart, Table 3.0

$$\begin{aligned} m_i, \text{ strata } 1 &= 9 && (\text{medium to fine grained, non-clastic carbonate limestone}) \\ m_i, \text{ strata } 2 &= 9 && (\text{medium to fine grained, non-clastic carbonate limestone}) \end{aligned}$$

4. Find strength parameters via Hoek-Brown's Mohr-Colomb method (Hoek 1994). See attached computer results  
 (note: in analysis use UCC lower bound, 5 ksi, or 35 MPa)

Strata 1 summary:     $\phi' = 56.6^\circ$  (use 2/3 of calculated value for this analysis,  $38^\circ$ )  
 $c' = 590 \text{ psf}$  (use 2/3 of calculated value for this analysis,  $400 \text{ psf}$ )

Strata 2 summary:     $\phi' = 55.9^\circ$  (use 2/3 of calculated value for this analysis,  $38^\circ$ )  
 $c' = 3110 \text{ psf}$  (use 2/3 of calculated value for this analysis,  $2080 \text{ psf}$ )

Hoek (1994)									
Rock Type	Limestone, Strata 2	n	sig3	sig1	ds1ds3	sign	tau	sign tau	sign sq
GSI	35	15	0.001	0.96413	17.049	0.05	0.22	0.01	0.00
Unconf Compr Str Intct Rock (MPa)	35	14	0.002	0.98219	16.771	0.06	0.23	0.01	0.00
mi	9	13	0.004	1.01745	16.255	0.06	0.24	0.01	0.00
mb	0.88	12	0.009	1.08493	15.359	0.07	0.26	0.02	0.01
s	0.001	11	0.017	1.20988	13.958	0.10	0.30	0.03	0.01
a	0.5	10	0.034	1.43097	12.065	0.14	0.37	0.05	0.02
E (MPa)	4217	611	9	0.068	1.8026	9.9123	0.23	0.50	0.11
ksi		8	0.137	2.39962	7.8302	0.39	0.72	0.28	0.15
phi	55.9								
cohesion		0.15	3.11	ksf					
Uniax Compr of Rock Mass (MPa)		0.97							

C1-14

Hoek (1994)

Rock Type	Limestone, Strata 1	n	sig3	sig1	ds1ds3	sign	tau	sign tau	sign sq
GSI	2.5	15	0.001	0.11687	94.387	0.00	0.01	0.00	0.00
Unconf Compr Str Intct Rock (MPa)	35	14	0.002	0.16876	65.9	0.00	0.02	0.00	0.00
mi	9	13	0.004	0.24404	46.103	0.01	0.03	0.00	0.00
mb	0.62	12	0.009	0.35355	32.345	0.02	0.06	0.00	0.00
s	0.000	11	0.017	0.51353	22.783	0.04	0.10	0.00	0.00
a	0.525	10	0.034	0.74853	16.138	0.08	0.17	0.01	0.01
E (MPa)	2371.4	344	9	0.068	1.09626	11.521	0.15	0.28	0.04
phi	56.6	ksi	8	0.137	1.6158	8.3114	0.30	0.46	0.14
Cohesion	0.03	0.59	ksf		Sums =	0.60	1.13	0.20	0.12
Uniax Compr of Rock Mass (MPa)	0.19								

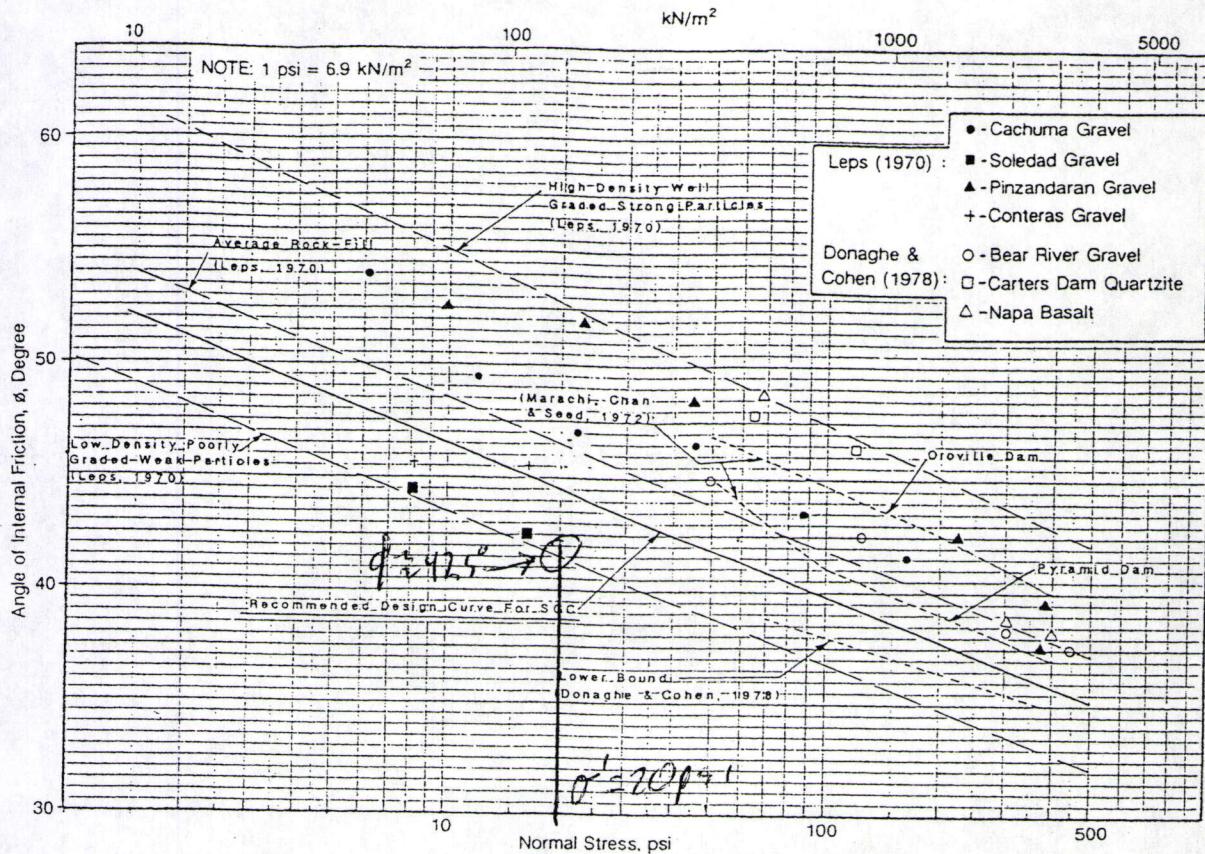


Figure 5. Effective stress friction angle of coarse granular materials.

#### 4.2 Determination of Shear Strength

The SGC is far too coarse to test by conventional methods. Thus, SGC shear strength is estimated from published triaxial shear tests (Marachi, et al. 1972; Marsal, 1974; Leps, 1970; Donaghe and Cohen, 1978, Barton and Kjaernsli, 1981) performed on coarse gravels for embankment dam design. Figure 5 depicts this test data in terms of drained angle of internal friction,  $\phi$  and normal stress, and shows the authors' recommended curve for SGC.

#### 4.3 Earth Pressure Coefficient (K)

The earth pressure coefficient is estimated based on geologic history, using the relationship between  $\phi$  and over-consolidation ratio (OCR) by Mayne and Kulhawy (1982). This relationship is shown on Figure 6 for primary unloading. The upper SGC deposits formed by Holocene deposition have been slightly overconsolidated by cycles of decline and rise of the water table. An average OCR of about 2 and  $K = 0.5$  is estimated for these deposits in accordance with Kulhawy and Beech (1987). The OCR of the older SGC

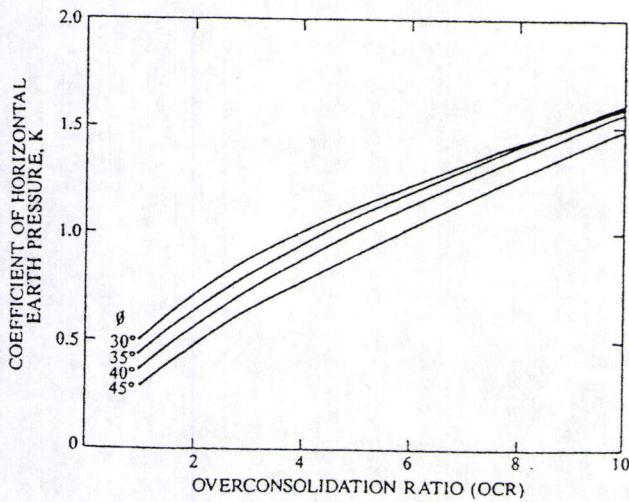


Figure 6. K -OCR relationship for primary unloading (after Mayne and Kulhawy, 1982).

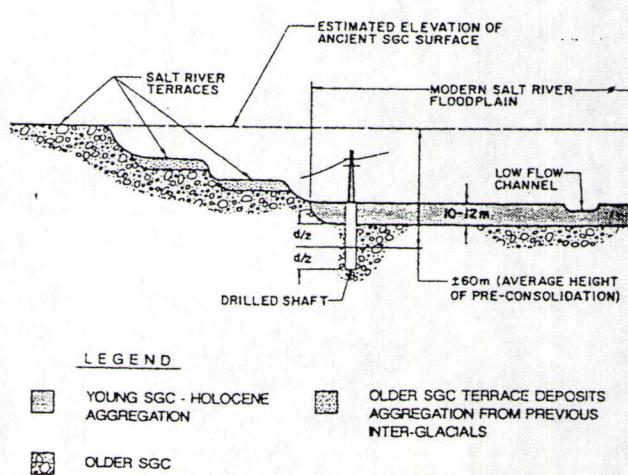


Figure 7. Schematic cross-section of Salt River channel.

## SLOPE STABILITY COMPUTER ANALYSIS RUNS

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d. Backfill failure, with reinforcement.....	C2-49

# Equipment Loads

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## Detailed Specifications

### Weights

Operating Weight 37875 kg (83500 lb)

Shipping Weight 29575 kg (65200 lb)

### Undercarriage

Pitch 216 mm (8.5 in)

Number Shoes/Side 44

Shoe Type Moderate Service Shoe

Length of Track on Ground 3206 mm (10.5 ft)

Ground Contact Area 3.58 m<sup>2</sup> (5554 in<sup>2</sup>)

Track Gauge 2082 mm (6.83 ft)

Width of Shoe 560 mm (22 in)

Grouser Height 78 mm (3 in)

Ground Clearance 528 m (1.75 ft)

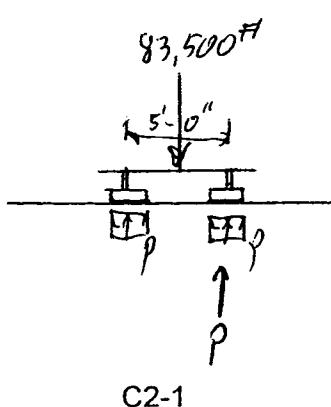
$$W_t = 83,500 \text{ #}$$

$$\text{Length} = 10.5' \text{ (track on ground)}$$

$$= 38,574^{\text{#}}$$

$$\text{Out-to-Out track separation} = 6.83'$$

$$\text{Track Width} = 1.83'$$



$$P = \frac{83,500 \text{ #}}{2 \text{ tracks}} = 41,750 \text{ #}$$

$$\frac{83,500 \text{ #}}{38,574^{\text{#}}} = 2,165 \text{ psf}$$

use 2170 psf  
in analysis

$$P = \frac{83,500 \text{ #}}{(10.5 \text{ ft})(2)} = 3976 \text{ #} \Rightarrow \text{use } 4000 \text{ #/ft}$$

# GEOGRIDS

Product Name	Manufacturing Process	Polymer Type [1]	Coating Type [1]	Dimensional Properties [2]		Wide Width Tensile - ASTM D 4595 [2], [3] kN/m (lb/ft)%						Creep Limited Strength T <sub>1</sub> [5] ASTM D 5262 kN/m (lb/ft)	T <sub>allow</sub> GNI GG4 [4] kN/m (lb/ft) (in sand)	Manufacturer's Suggested Applications [6]			
				Mass/Unit Area ASTM D 5261 g/m <sup>2</sup> (oz/yd <sup>2</sup> )	Aperture Size mm (in)	Strength @ 5% Strain		Ultimate Strength/M% (T <sub>ub</sub> ) [4]									
						MD	XD	MD	XD	MD	XD						

## Lückenhau North America Inc. (cont.)

Raugrid 3/3-20	woven, 5m wide	PET	PVC	273 (8.0)	20 (0.8)	20 (0.8)	10.4 (712)	7.9 (541)	32.6/10.8 (2213)	32.3/11.9 (2213)	21.4 (1466)	17.0 (1165)	B, W, S, E
Raugrid 4/2-15	woven, 5m wide	PET	PVC	260 (7.7)	15 (0.6)	15 (0.6)	11.2 (767)	5.2 (356)	41.5/11.8 (2843)	21.3/11.9 (1459)	27.3 (1870)	21.6 (1480)	B, W, S, E
Raugrid 6/3-15	woven, 5m wide	PET	PVC	360 (10.6)	15 (0.6)	15 (0.6)	16.7 (1144)	6.6 (452)	63.5/13/1 (4350)	28.6/12.1 (1959)	41.7 (2856)	33.0 (2260)	B, W, S, E
Raugrid 8/3-20	woven, 5m wide	PET	PVC	438 (12.9)	20 (0.8)	20 (0.8)	17.0 (1165)	7.4 (507)	77.2/12.2 (5288)	30.5/11.4 (2089)	50.7 (3473)	40.2 (2754)	B, W, S, E
Raugrid 10/3-20	woven, 5m wide	PET	PVC	535 (15.8)	20 (0.8)	20 (0.8)	23.1 (1582)	7.6 (521)	98.0/11.5 (6715)	32.0/11.2 (2192)	63.3 (4336)	51.0 (3492)	B, W, S, E
Raugrid 13/3-20	woven, 5m wide	PET	PVC	615 (18.1)	20 (0.8)	20 (0.8)	29.0 (1987)	7.9 (541)	129.3/15.8 (8857)	31.5/13.0 (2158)	85.1 (5830)	67.3 (4615)	B, W, S, E
Raugrid 15/3-20	woven, 5m wide	PET	PVC	644 (19.0)	20 (0.8)	20 (0.8)	33.8 (2315)	7.5 (514)	152.9/11.8 (10,474)	34.6/12.8 (2370)	100.5 (6884)	79.5 (5445)	B, W, S, E
Raugrid 20/3-20	woven, 5m wide	PET	PVC	650 (19.2)	20 (0.8)	20 (0.8)	NA	NA	215.3/13.0 (14,748)	NA	141.6 (9700)	111.9 (7665)	B, W, S, E

## Lückenhau North America Inc. (cont.)

STAR Grid +PF	woven + nonwoven	PET	bituminous	415 (12.2)	30 (1.2)	30 (1.2)	13.3 (911)	9.7 (664)	62.2/9.1 (4261)	58.5/10.2 (4007)	NA	NA	asphalt reinforcement, water barrier
STAR Grid G-PS	woven + interlayered filling yarn	fiberglass	bituminous	355 (10.5)	30 (1.2)	30 (1.2)	NA	NA	50.3/1.7 (3446)	51.6/1.1 (3535)	NA	NA	A/O
STAR Grid G-PS 100	woven + interlayered filling yarn	fiberglass	bituminous	550 (16.2)	30 (1.2)	30 (1.2)	NA	NA	97.6/1.6 (6690)	102.5/0.7 (7025)	NA	NA	asphalt reinforcement, water barrier

## Maccaferri Gabions Inc.

ParaGrid 50/15	extruded/cross-bonded	PET	LDPE	415 (12.2)/ 350 (10.2)	201 (7.9)	51 (2.00)	21 (1439)	6 (411)	50/10 (3425)	15/10 (1027)	32 (2196)	29.4 (2011)	W, S, E, B
ParaGrid 80/15	extruded/cross-bonded	PET	LDPE	465 (13.7)/ 420 (12.6)	201 (7.9)	51 (2.00)	33.6 (2302)	6 (411)	80/10 (5480)	15/10 (1027)	51.3 (2513)	47 (3217)	W, S, E, B
ParaGrid 100/15	extruded/cross-bonded	PET	LDPE	525 (15.4)/ 480 (14.1)	201 (7.9)	51 (2.00)	42 (2877)	6 (411)	100/10 (6849)	15/10 (1027)	64.1 (4390)	58.7 (4021)	W, S, E, B
ParaGrid 150/15	extruded/cross-bonded	PET	LDPE	665 (19.6)/ 600 (17.6)	201 (7.9)	42 (1.65)	63 (4316)	6 (411)	150/10 (10,274)	15/10 (1027)	96.2 (6586)	88.1 (6031)	W, S, E, B

[1] PET = Polyester

EP = Elastomeric Polymer

TG = Fiberglass

TD = Machine direction

[2] MD = Cross-machine direction

[3] Test is for geotextiles and must be modified for geogrids.

[4] T<sub>allow</sub> = T<sub>ub</sub> × R<sub>MD</sub> × R<sub>XD</sub>R<sub>MD</sub> = Reduction factor for creepR<sub>XD</sub> = Reduction factor for installation damageR<sub>TD</sub> = Reduction factor for durability

NOTE: Equation does not include other reduction factors that may apply to design. Reduction factors are site-specific and should be reviewed on a per-project basis. Contact the manufacturer for recommendations.

[5] Test per ASTM D 5262, for a minimum of 10,000 hours and extrapolate to a 25-year time period.

[6] E = Embankments

S = Slopes

AO = Asphalt overlay

PR = Pavement reinforcement

NP = Not provided by manufacturer

NA = Not applicable per manufacturer

Companies were requested to provide minimum average roll values (MARV). All claims are the responsibility of the manufacturer.

GCR recommends you contact the manufacturers before making any specifying/purchasing decisions.

# GEOGRIDS

Gabion Walls calculation - GAWAC BR02  
MACCAFERRI GABIONS INC. - SACRAMENTO (CA)

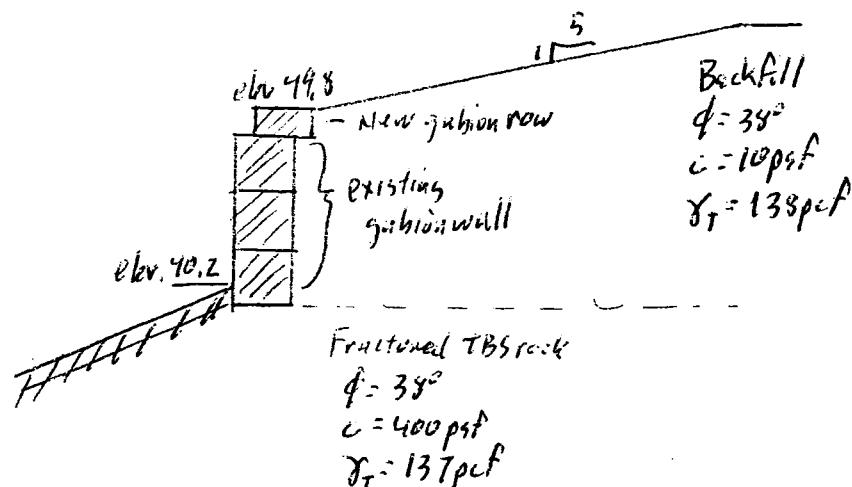
File: LOWGAB1 Project : UMCC Lower Gabion Wall - final condition

\*\*\*\*\*  
DATA INPUT PAGE 1  
\*\*\*\*\*

#### WALL DATA

Wall batter [deg]..... 0.00 Layer Length Height Init.  
Rockfill unit weight [lb/ft<sup>3</sup>]..155.00 [ft] [ft] [ft]  
Porosity of gabions..... 0.20 -----  
Geotextile in backfill..... No 1 3.00 3.00  
Friction reduction [%]..... 2 3.00 3.00 0.00  
Geotextile under the base..... Yes 3 3.00 2.50 0.00  
Friction reduction [%]..... 0.16 4 3.00 2.00 1.00

Lower Gabion Wall  
- after construction  
- long-term conditions  
- backfill loads only



#### GEOMETRICAL PARAMETERS OF BACKFILL

Inclination of the first stretch [deg]..... 11.30  
Length of the stretch [ft]..... 23.00  
Inclination of the second stretch [deg]..... 0.00

#### BACKFILL SOIL DATA

Unit weight of soil [lb/ft<sup>3</sup>].....138.00  
Friction angle [deg]..... 38.00  
Cohesion [lb/ft<sup>2</sup>]..... 10.00

#### BACKFILL SOIL ADDITIONAL DATA

Layer	Initial Height [ft]	Inclin. angle [deg]	Unit weight [lb/ft <sup>3</sup> ]	Cohesion [lb/ft <sup>2</sup> ]	Frict. angle [deg]
-------	---------------------	---------------------	-----------------------------------	--------------------------------	--------------------

Gabion Walls calculation - GAWAC BR02  
MACCAFERRI GABIONS INC. - SACRAMENTO (CA)

File: LOWGAB1 Project : UMCC Lower Gabion Wall - final condition

\*\*\*\*\*  
DATA INPUT PAGE 2  
\*\*\*\*\*

DATA ABOUT THE UPHILL WATER SURFACE

Initial height [ft].....:  
Inclination of the first stretch [deg].....:  
Length of the stretch [ft].....:  
Inclination of the second stretch [deg].....:  
Length of the stretch [ft].....:

GEOMETRICAL DATA ABOUT FOUNDATION SOIL

Elev. of placing from the base [ft].....: 0.90  
Soil inclination ref.to base [deg].....: 21.40

DATA ABOUT FOUNDATION SOIL

Unit weight of soil [lb/ft<sup>3</sup>].....:137.00  
Friction angle [deg].....: 38.00  
Cohesion [lb/ft<sup>2</sup>].....:400.00  
Allowable stress on foundation [lb/ft<sup>2</sup>].....:3000.00  
Water level [ft].....: 0.00

DATA ABOUT ADDITIONAL FOUNDATION SOILS

Layer	Depth	Unit weight	Cohesion	Frict.angle
	[ft]	[lb/ft <sup>3</sup> ]	[lb/ft <sup>2</sup> ]	[deg]
-----	-----	-----	-----	-----

DATA ABOUT DISTRIBUTED LOADS

Distributed loads on backfill  
First stretch [lb/ft<sup>2</sup>]...: Second stretch [lb/ft<sup>2</sup>]...:  
Distr. loads on the wall  
Surcharge load [lb/ft<sup>2</sup>]...:

Point loads on the backfill  
1.Load [lb/ft].....: Dist. from wall top [ft]..  
2.Load [lb/ft].....: Dist. from wall top [ft]..  
3.Load [lb/ft].....: Dist. from wall top [ft]..

Point loads on the wall  
Surcharge load [lb/ft<sup>2</sup>]...: Dist. from wall top [ft]..

DATA ABOUT SEISMIC ACTIONS

Horizontal coefficient...: Vertical coefficient....:

Gabion Walls calculation - GAWAC BR02  
MACCAFERRI GABIONS INC. - SACRAMENTO (CA)

File: LOWGAB1 Project : UMCC Lower Gabion Wall - final condition

\*\*\*\*\*  
RESULTS PAGE 3  
\*\*\*\*\*

#### EXTERNAL STABILITY

Active thrust [lb/ft].....: 1479.56  
Point of application ref. to X axis [ft].....: 3.32  
Point of application ref. to Y axis [ft].....: 3.36  
Direction of thrust ref. to X axis [deg].....: 32.56

Passive thrust [lb/ft].....: 1553.88  
Point of application ref. to X axis [ft].....: 0.00  
Point of application ref. to Y axis [ft].....: 0.43  
Direction of thrust ref. to X axis [deg].....: -21.40

#### SLIDING

Normal force on the base [lb/ft].....:-4538.29  
Point of application ref. to X axis [ft].....: 1.54  
Point of application ref. to Y axis [ft].....: 0.00  
Shear force on the base [lb/ft].....: 199.73  
Resisting force on the base [lb/ft].....: 5586.78

Safety coefficient.....: 4.480 *> 2.0 OK*

#### OVERTURNING

Overturning moment [lbft/ft].....: 4194.01  
Restoring moment [lbft/ft].....: 11174.82

Safety coefficient.....: 2.664 *> 1.5 OK*

#### STRESSES ACTING ON FOUNDATION

Stress on outer foundation border [lb/ft<sup>2</sup>]....: 1397.18  
Stress on inner foundation border [lb/ft<sup>2</sup>]....: 1628.35  
Max. allow. stress on the foundation [lb/ft<sup>2</sup>]..: 3000.00

*3 A<sub>av</sub> = 1513 psf OK*

*\* Per Bowles, 1996*

Gabion Walls calculation - GAWAC BR02  
MACCAFERRI GABIONS INC. - SACRAMENTO (CA)

File: LOWGAB1 Project : UMCC Lower Gabion Wall - final condition

\*\*\*\*\*  
RESULTS PAGE 4  
\*\*\*\*\*

#### OVERALL STABILITY

Initial distance at pivot leftside [ft].....:  
Initial distance at pivot rightside [ft].....:  
Initial depth referred to base [ft].....:  
Max. depth allowed in the calculation [ft].....:  
Center of the arc referred to X axis [ft].....: -6.30  
Center of the arc referred to Y axis [ft].....: 18.89  
Radius of the arc [ft].....: 22.44  
Number of search surfaces .....: 56  
  
Safety coefficient.....: 2.015

> 1.5 ok ( w/out geogrid )

#### INTERNAL STABILITY

Layer	H [ft]	N [lb/ft]	T [lb/ft]	M [lbft/ft]	tmax [lb/ft <sup>2</sup> ]	tad [lb/ft <sup>2</sup> ]	smax [lb/ft <sup>2</sup> ]
-----							
1	7.50	3346.06	577.79	5374.78	192.60	1467.35	1041.54
2	4.50	1780.30	158.07	3358.17	52.69	1034.70	471.90
3	2.00	776.72	41.88	1190.92	13.96	757.40	253.29

Allowable normal pressure [lb/ft<sup>2</sup>].....: 14196.98

\*\*\*\*\*

#### NOTICE

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geotechnical parameters assumed, nor the improper  
use of the software. The GAWAC program should be  
used only in conjunction with Maccaferri products

\*\*\*\*\* C26 \*\*\*\*\*

*Lower Grabin Wall*

\*\*\*\*\*  
\*\*\*\* RSS \*\*\*\*  
\*\*\*\* Reinforced Slope Stability \*\*\*\*  
\*\*\*\*  
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\*\*\*\*\*

File : D:\RSSreclut.dat

Date : Fri 08-24-1, 10:12:17

Name : Reclaimed Test Pit Slope

Problem Title : Reinforced Slope (ParaGrid 50/15 Geogrid)

Description : saturated overburden, normal in embankment

Remarks :

\*\*\*\*\*  
\*\*\*\* INPUT DATA \*\*\*\*  
\*\*\*\*\*

Profile Boundaries

Number of Boundaries : 33

Number of Top Boundaries : 18

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	22.50	35.50	38.00	35.50	3
2	38.00	35.50	46.90	38.60	3
3	46.90	38.60	50.00	40.20	4
4	50.00	40.20	54.80	40.20	4
5	54.80	40.20	54.90	41.20	2
6	54.90	41.20	55.00	49.80	1
7	55.00	49.80	77.50	54.80	1
8	77.50	54.80	82.30	54.80	1
9	82.30	54.80	82.50	63.80	1
10	82.50	63.80	96.90	65.00	1
11	96.90	65.00	97.90	65.00	2
12	97.90	65.00	100.30	74.30	4
13	100.30	74.30	106.30	74.30	4
14	106.30	74.30	109.40	79.10	4
15	109.40	79.10	129.40	100.60	3
16	129.40	100.60	133.50	101.30	3
17	133.50	101.30	136.50	105.00	3
18	136.50	105.00	145.00	112.50	3
19	109.40	79.10	145.00	96.00	4
20	54.90	41.20	93.00	48.00	2
21	93.00	48.00	96.90	65.00	2
22	54.80	40.20	79.50	44.50	4
23	79.50	44.50	94.00	47.00	5
24	94.00	47.00	95.90	55.30	5
25	95.90	55.30	97.90	65.00	4
26	22.50	29.10	34.10	29.50	5
27	34.10	29.50	42.00	35.10	5
28	42.00	35.10	46.90	38.60	4
29	42.00	35.10	63.00	38.80	5
30	63.00	38.80	75.90	43.50	5
31	75.90	43.50	79.50	44.50	5
32	95.90	55.30	102.60	67.60	5
33	102.60	67.60	145.00	71.70	5

**Soil Parameters**

Number of Soil Types : 5

Type	Total Wt.	Saturated Wt.	Cohesion	Fric. Angle	Pore Pressure	Constant Surface	Piez.
No.	(pcf)	(pcf)	(psf)	(deg)	Param.	(psf)	No.
1	138.0	140.0	10.0	38.0	0.00	0.0	0
2	125.0	130.0	0.0	38.0	0.00	0.0	0
3	134.0	134.0	100.0	34.0	0.00	0.0	0
4	137.0	141.0	400.0	38.0	0.00	0.0	0
5	152.0	155.0	2080.0	38.0	0.00	0.0	0

**Boundary Loads**

Number of Loads : 2

Load No.	X-Left (ft)	X-Right (ft)	Intensity (psf)	Inclination (deg)
1	50.00	54.80	1500.0	0.0
2	77.50	82.30	1500.0	0.0

**Data for Reinforcement Analysis**

Lowest Elevation for Reinforcement : 43.80 ft

Highest Elevation for Reinforcement : 54.80 ft

Minimum Embedment Length : 3.00 ft

Strength Option : Long Term Strength

Extension Factor : 1.00

Reduction Factor : 7.00

PULLOUT Factor of Safety : 2.00

PULLOUT Resistance Factor : 0.54

Embedded Scale Factor : 0.67

Slope Coefficient of Friction : 0.67

Foundation Coefficient of Friction : 0.67

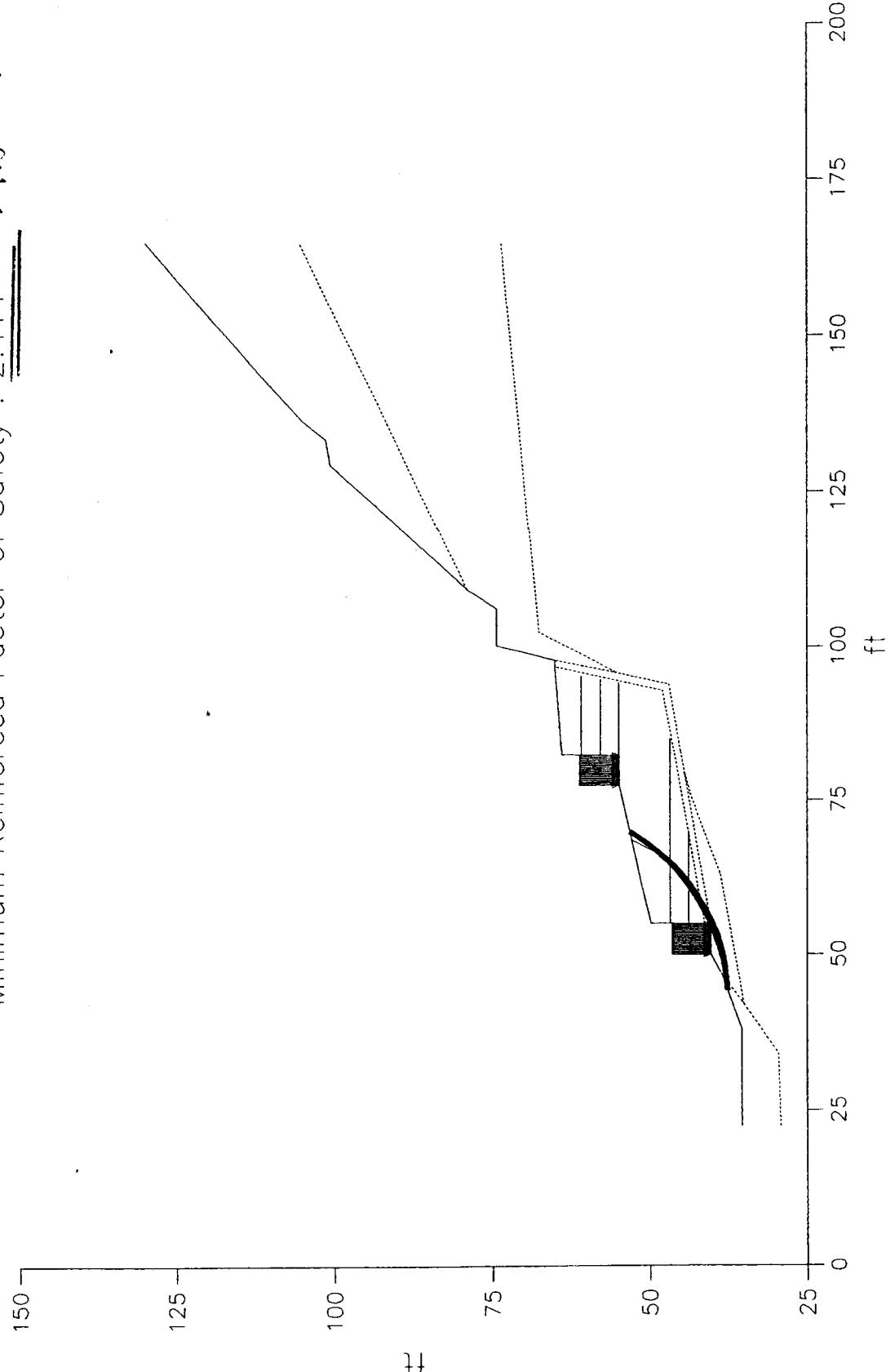
Layer No.	Elevation (ft)	Length (ft)	Long Term Strength (lb/ft)	Ultimate Strength (lb/ft)
1	43.80	15.00	2011.00	3425.00
2	46.80	30.00	2011.00	3425.00
3	54.90	12.00	2011.00	3425.00
4	57.80	12.50	2011.00	3425.00
5	60.80	13.00	2011.00	3425.00

↑  
per attached sheet

Title : Reinforced Slope (ParaGrid 50/15 Geogrid)  
Description : saturated overburden, normal in embankment

Reinforcement Analysis - Most Critical Surfaces

Minimum Reinforced Factor of Safety : 2.411  $> 1.5 \text{ ok}$



Gabion Walls calculation - GAWAC BR02  
MACCAFERRI GABIONS INC. - SACRAMENTO (CA)

File: LOWGAB1A Project : UMCC Lower Gabion Wall - backfill loads

Lower Gabion Wall

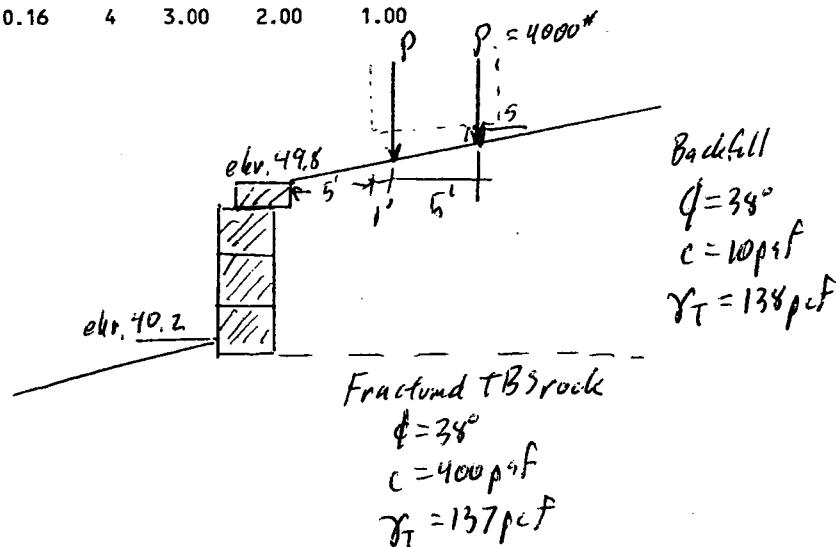
- during construction
- short-term load
- backfill & equipment loads

\*\*\*\*\*  
DATA INPUT  
\*\*\*\*\*

PAGE 1

WALL DATA

Wall batter [deg].....	0.00	Layer	Length	Height	Init.
Rockfill unit weight [lb/ft <sup>3</sup> ].....	155.00		[ft]	[ft]	[ft]
Porosity of gabions.....	0.20				
Geotextile in backfill.....	No	1	3.00	3.00	
Friction reduction [%].....		2	3.00	3.00	0.00
Geotextile under the base.....	Yes	3	3.00	2.50	0.00
Friction reduction [%].....	0.16	4	3.00	2.00	1.00



-----  
GEOMETRICAL PARAMETERS OF BACKFILL

Inclination of the first stretch [deg].....	11.30
Length of the stretch [ft].....	23.00
Inclination of the second stretch [deg].....	0.00

BACKFILL SOIL DATA

Unit weight of soil [lb/ft <sup>3</sup> ].....	138.00
Friction angle [deg].....	38.00
Cohesion [lb/ft <sup>2</sup> ].....	10.00

BACKFILL SOIL ADDITIONAL DATA

Layer	Initial Height [ft]	Inclin. angle [deg]	Unit weight [lb/ft <sup>3</sup> ]	Cohesion [lb/ft <sup>2</sup> ]	Frict. angle [deg]
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Gabion Walls calculation - GAWAC BR02  
MACCAFERRI GABIONS INC. - SACRAMENTO (CA)

File: LOWGAB1A Project : UMCC Lower Gabion Wall - backfill loads

\*\*\*\*\*  
DATA INPUT PAGE 2  
\*\*\*\*\*

DATA ABOUT THE UPHILL WATER SURFACE

Initial height [ft].....:  
Inclination of the first stretch [deg].....:  
Length of the stretch [ft].....:  
Inclination of the second stretch [deg].....:  
Length of the stretch [ft].....:

GEOMETRICAL DATA ABOUT FOUNDATION SOIL

Elev. of placing from the base [ft].....: 0.90  
Soil inclination ref.to base [deg].....: 21.40

DATAI ABOUT FOUNDATION SOIL

Unit weight of soil [lb/ft<sup>3</sup>].....:137.00  
Friction angle [deg].....: 38.00  
Cohesion [lb/ft<sup>2</sup>].....:400.00  
Allowable stress on foundation [lb/ft<sup>2</sup>].....:3000.00  
Water level [ft].....: 0.00

DATA ABOUT ADDITIONAL FOUNDATION SOILS

Layer	Depth [ft]	Unit weight [lb/ft <sup>3</sup> ]	Cohesion [lb/ft <sup>2</sup> ]	Frict.angle [deg]
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DATA ABOUT DISTRIBUTED LOADS

Distributed loads on backfill

First stretch [lb/ft<sup>2</sup>]...: Second stretch [lb/ft<sup>2</sup>]...:  
Distr. loads on the wall  
Surcharge load [lb/ft<sup>2</sup>]...:

Point loads on the backfill

1.Load [lb/ft].....:4000.00 Dist. from wall top [ft]..: 6.00  
2.Load [lb/ft].....:4000.00 Dist. from wall top [ft]..: 11.00  
3.Load [lb/ft].....: Dist. from wall top [ft]..:

Point loads on the wall

Surcharge load [lb/ft<sup>2</sup>]...: Dist. from wall top [ft]..:

DATA ABOUT SEISMIC ACTIONS

Horizontal coefficient...: Vertical coefficient.....:  
C2-11

Gabion Walls calculation - GAWAC BR02  
MACCAFERRI GABIONS INC. - SACRAMENTO (CA)

File: LOWGAB1A Project : UMCC Lower Gabion Wall - backfill loads

\*\*\*\*\*  
RESULTS PAGE 3  
\*\*\*\*\*

#### EXTERNAL STABILITY

Active thrust [lb/ft].....: 2875.01  
Point of application ref. to X axis [ft].....: 3.32  
Point of application ref. to Y axis [ft].....: 3.40  
Direction of thrust ref. to X axis [deg].....: 32.56

Passive thrust [lb/ft].....: 1553.88  
Point of application ref. to X axis [ft].....: 0.00  
Point of application ref. to Y axis [ft].....: 0.43  
Direction of thrust ref. to X axis [deg].....: -21.40

#### SLIDING

Normal force on the base [lb/ft].....: 5289.29  
Point of application ref. to X axis [ft].....: 1.03  
Point of application ref. to Y axis [ft].....: 0.00  
Shear force on the base [lb/ft].....: 976.40  
Resisting force on the base [lb/ft].....: 6172.59

Safety coefficient.....: 2.547 > 1.5 OK

#### OVERTURNING

Overturning moment [lbft/ft].....: 8233.28  
Restoring moment [lbft/ft].....: 13673.47

Safety coefficient.....: 1.661 ≠ 2.0 low

#### STRESSES ACTING ON FOUNDATION

Stress on outer foundation border [lb/ft<sup>2</sup>]....: 3425.59  
Stress on inner foundation border [lb/ft<sup>2</sup>]....: 100.60  
Max. allow. stress on the foundation [lb/ft<sup>2</sup>]..: 3000.00

Gabion Walls calculation - GAWAC BR02  
MACCAFERRI GABIONS INC. - SACRAMENTO (CA)

File: LOWGAB1A Project : UMCC Lower Gabion Wall - backfill loads

\*\*\*\*\*  
RESULTS PAGE 4  
\*\*\*\*\*

#### OVERALL STABILITY

Initial distance at pivot leftside [ft].....:  
Initial distance at pivot rightside [ft].....:  
Initial depth referred to base [ft].....:  
Max. depth allowed in the calculation [ft].....:  
Center of the arc referred to X axis [ft].....: -6.23  
Center of the arc referred to Y axis [ft].....: 21.10  
Radius of the arc [ft].....: 23.04  
Number of search surfaces .....: 117

Safety coefficient.....: 1.454 > 1.2 OK

#### INTERNAL STABILITY

Layer	H [ft]	N [lb/ft]	T [lb/ft]	M [lbft/ft]	tmax [lb/ft2]	tad [lb/ft2]	smax [lb/ft2]
1	7.50	3700.14	1181.17	5874.53	393.72	1565.19	1165.29
2	4.50	1780.30	158.07	3358.17	52.69	1034.70	471.90
3	2.00	776.72	41.88	1190.92	13.96	757.40	253.29

Allowable normal pressure [lb/ft2].....: 14196.98

#### NOTICE

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*Lower Grabion  
- equipment loads*

\*\*\*\*\*  
\*\*\*\* RSS \*\*\*\*  
\*\*\*\* Reinforced Slope Stability \*\*\*\*  
\*\*\*\*  
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\*\*\*\*\*

File : D:\RSS\reclut1.dat

Date : Fri 08-24-1, 10:12:17

Name : Reclaimed Test Pit Slope

Problem Title : Reinforced Slope (ParaGrid 50/15 Geogrid)

Description : saturated overburden, normal in embankment

Remarks :

\*\*\*\*\*  
\*\*\*\* INPUT DATA \*\*\*\*  
\*\*\*\*\*

Profile Boundaries

Number of Boundaries : 33

Number of Top Boundaries : 18

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	22.50	35.50	38.00	35.50	3
2	38.00	35.50	46.90	38.60	3
3	46.90	38.60	50.00	40.20	4
4	50.00	40.20	54.80	40.20	4
5	54.80	40.20	54.90	41.20	2
6	54.90	41.20	55.00	49.80	1
7	55.00	49.80	77.50	54.80	1
8	77.50	54.80	82.30	54.80	1
9	82.30	54.80	82.50	63.80	1
10	82.50	63.80	96.90	65.00	1
11	96.90	65.00	97.90	65.00	2
12	97.90	65.00	100.30	74.30	4
13	100.30	74.30	106.30	74.30	4
14	106.30	74.30	109.40	79.10	4
15	109.40	79.10	129.40	100.60	3
16	129.40	100.60	133.50	101.30	3
17	133.50	101.30	136.50	105.00	3
18	136.50	105.00	145.00	112.50	3
19	109.40	79.10	145.00	96.00	4
20	54.90	41.20	93.00	48.00	2
21	93.00	48.00	96.90	65.00	2
22	54.80	40.20	79.50	44.50	4
23	79.50	44.50	94.00	47.00	5
24	94.00	47.00	95.90	55.30	5
25	95.90	55.30	97.90	65.00	4
26	22.50	29.10	34.10	29.50	5
27	34.10	29.50	42.00	35.10	5
28	42.00	35.10	46.90	38.60	4
29	42.00	35.10	63.00	38.80	5
30	63.00	38.80	75.90	43.50	5
31	75.90	43.50	79.50	44.50	5
32	95.90	55.30	102.60	67.60	5
33	102.60	67.60	145.00	71.70	5

**Soil Parameters**

Number of Soil Types : 5

Soil Type	Total Wt.	Saturated Wt.	Cohesion	Friction Angle	Pore Pressure	Constant Piez.	Surface No.
No.	(pcf)	(pcf)	(psf)	(deg)	Param.	(psf)	
1	138.0	140.0	10.0	38.0	0.00	0.0	0
2	125.0	130.0	0.0	38.0	0.00	0.0	0
3	134.0	134.0	100.0	34.0	0.00	0.0	0
4	137.0	141.0	400.0	38.0	0.00	0.0	0
5	152.0	155.0	2080.0	38.0	0.00	0.0	0

**Boundary Loads**

Number of Loads : 4

Load No.	X-Left (ft)	X-Right (ft)	Intensity (psf)	Inclination (deg)
1	50.00	54.80	1500.0	0.0
2	57.08	58.92	2170.0	0.0
3	62.08	63.92	2170.0	0.0
4	77.50	82.30	1500.0	0.0

**Data for Reinforcement Analysis**

Lowest Elevation for Reinforcement : 43.80 ft

Highest Elevation for Reinforcement : 54.80 ft

Minimum Embedment Length : 3.00 ft

Strength Option : Long Term Strength

Extension Factor : 1.00

Reduction Factor : 7.00

Pulldown Factor of Safety : 2.00

Pulldown Resistance Factor : 0.54

Embedded Scale Factor : 0.67

Slope Coefficient of Friction : 0.67

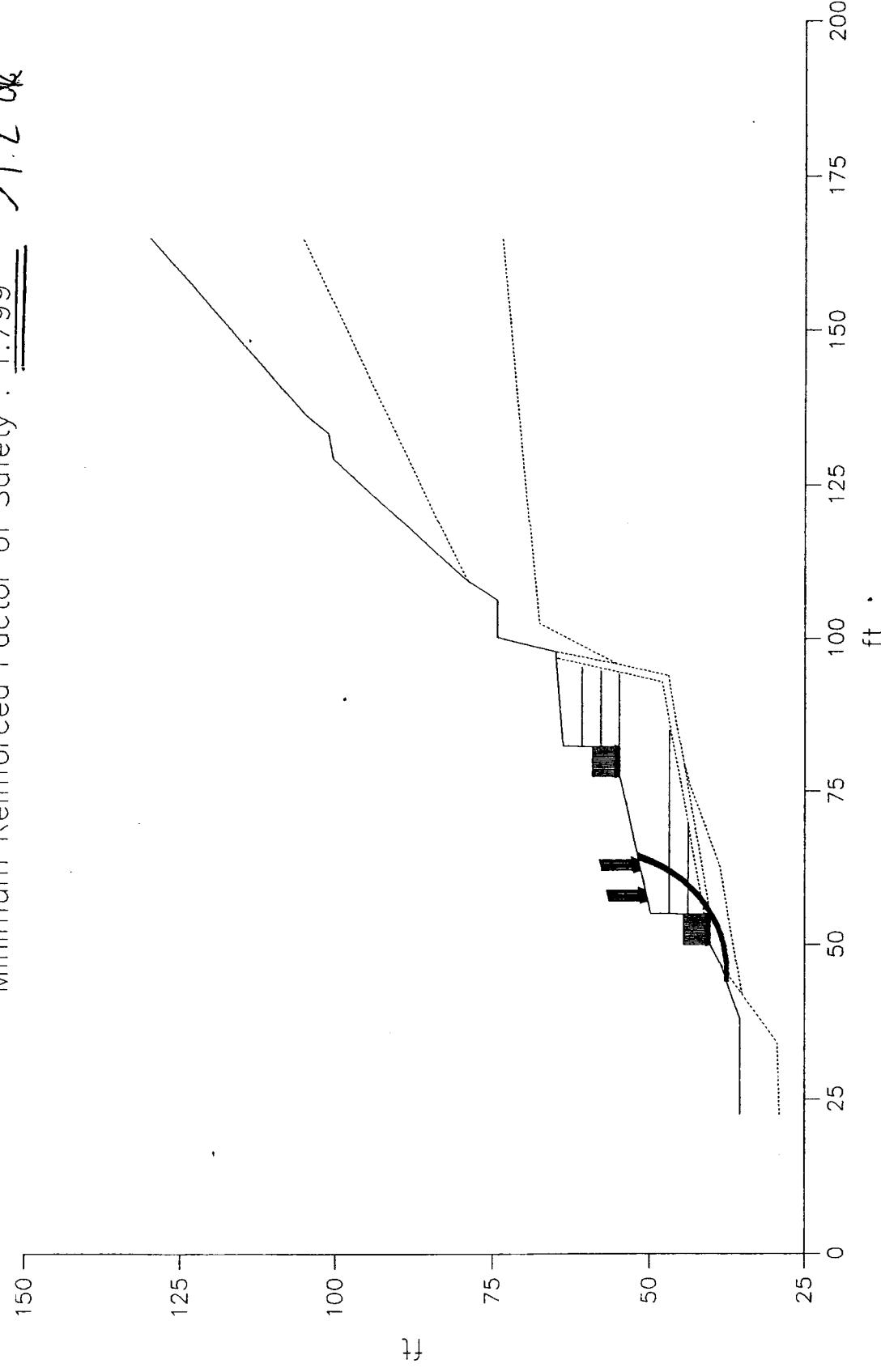
Foundation Coefficient of Friction : 0.67

Layer No.	Elevation (ft)	Length (ft)	Long Term Strength (lb/ft)	Ultimate Strength (lb/ft)
1	43.80	15.00	2011.00	3425.00
2	46.80	30.00	2011.00	3425.00
3	54.90	12.00	2011.00	3425.00
4	57.80	12.50	2011.00	3425.00
5	60.80	13.00	2011.00	3425.00

Title : Reinforced Slope (ParaGrid 50/15 Geogrid)  
Description : saturated overburden, normal in embankment

Reinforcement Analysis - Most Critical Surfaces

Minimum Reinforced Factor of Safety : 1.799  $> 1.2 \text{ ok}$



Gabion Walls calculation - GAWAC BR02  
MACCAFERRI GABIONS INC. - SACRAMENTO (CA)

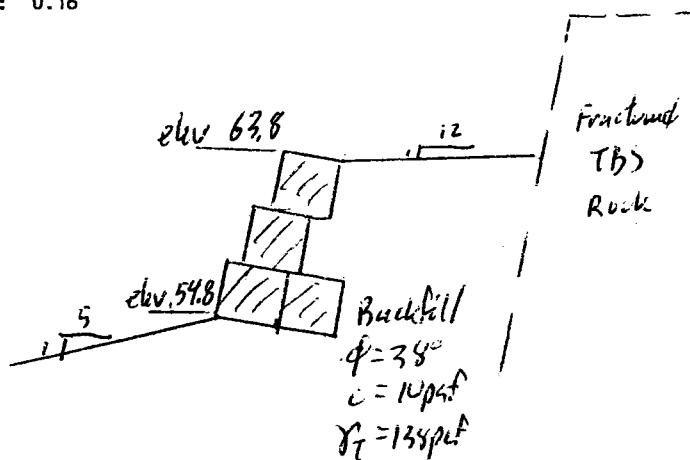
File: HIGAB1 Project : UMCC Upper Gabion Wall - final condition

\*\*\*\*\*  
DATA INPUT PAGE 1  
\*\*\*\*\*

#### WALL DATA

Wall batter [deg]..... 10.00 Layer Length Height Init.  
Rockfill unit weight [lb/ft<sup>3</sup>]..155.00 [ft] [ft] [ft]  
Porosity of gabions..... 0.20 -----  
Geotextile in backfill..... No 1 6.00 3.00  
Friction reduction [%]..... 2 3.00 3.00 1.00  
Geotextile under the base..... Yes 3 3.00 2.50 2.00  
Friction reduction [%]..... 0.16

Upper Gabion Wall  
- after construction  
- long-term conditions  
- backfill loads only



#### GEOMETRICAL PARAMETERS OF BACKFILL

Inclination of the first stretch [deg]..... 4.76  
Length of the stretch [ft]..... 10.00  
Inclination of the second stretch [deg]..... 0.00

#### BACKFILL SOIL DATA

Unit weight of soil [lb/ft<sup>3</sup>].....138.00  
Friction angle [deg]..... 38.00  
Cohesion [lb/ft<sup>2</sup>]..... 10.00

#### BACKFILL SOIL ADDITIONAL DATA

Layer	Initial Height	Inclin. angle [deg]	Unit weight [lb/ft <sup>3</sup> ]	Cohesion [lb/ft <sup>2</sup> ]	Frict. angle [deg]
-------	----------------	---------------------	-----------------------------------	--------------------------------	--------------------

Gabion Walls calculation - GAWAC BR02  
MACCAFERRI GABIONS INC. - SACRAMENTO (CA)

File: HIGAB1 Project : UMCC Upper Gabion Wall - final condition

\*\*\*\*\*  
DATA INPUT PAGE 2  
\*\*\*\*\*

DATA ABOUT THE UPHILL WATER SURFACE

Initial height [ft].....:  
Inclination of the first stretch [deg].....:  
Length of the stretch [ft].....:  
Inclination of the second stretch [deg].....:  
Length of the stretch [ft].....:

GEOMETRICAL DATA ABOUT FOUNDATION SOIL

Elev. of placing from the base [ft].....: 0.00  
Soil inclination ref.to base [deg].....: 11.30

DATAI ABOUT FOUNDATION SOIL

Unit weight of soil [lb/ft<sup>3</sup>].....:138.00  
Friction angle [deg].....: 38.00  
Cohesion [lb/ft<sup>2</sup>].....: 10.00  
Allowable stress on foundation [lb/ft<sup>2</sup>].....:3000.00  
Water level [ft].....: 0.00

DATA ABOUT ADDITIONAL FOUNDATION SOILS

Layer	Depth [ft]	Unit weight [lb/ft <sup>3</sup> ]	Cohesion [lb/ft <sup>2</sup> ]	Frict.angle [deg]
-----	-----	-----	-----	-----

DATA ABOUT DISTRIBUTED LOADS

Distributed loads on backfill

First stretch [lb/ft<sup>2</sup>]...: Second stretch [lb/ft<sup>2</sup>]...:  
Distr. loads on the wall  
Surcharge load [lb/ft<sup>2</sup>]...:

Point loads on the backfill

1.Load [lb/ft].....: Dist. from wall top [ft]..  
2.Load [lb/ft].....: Dist. from wall top [ft]..  
3.Load [lb/ft].....: Dist. from wall top [ft]..

Point loads on the wall

Surcharge load [lb/ft<sup>2</sup>]...: Dist. from wall top [ft]..

DATA ABOUT SEISMIC ACTIONS

Horizontal coefficient...: Vertical coefficient....:

Gabion Walls calculation - GAWAC BR02  
MACCAFERRI GABIONS INC. - SACRAMENTO (CA)

File: HIGAB1 Project : UMCC Upper Gabion Wall - final condition

\*\*\*\*\*  
RESULTS PAGE 3  
\*\*\*\*\*

EXTERNAL STABILITY

Active thrust [lb/ft].....: 946.74  
Point of application ref. to X axis [ft].....: 6.06  
Point of application ref. to Y axis [ft].....: 1.63  
Direction of thrust ref. to X axis [deg].....: 34.71

Passive thrust [lb/ft].....: 0.00  
Point of application ref. to X axis [ft].....: 0.00  
Point of application ref. to Y axis [ft].....: 0.00  
Direction of thrust ref. to X axis [deg].....: -11.30

SLIDING

Normal force on the base [lb/ft].....: 5398.05  
Point of application ref. to X axis [ft].....: 3.71  
Point of application ref. to Y axis [ft].....: -0.65  
Shear force on the base [lb/ft].....: -161.55  
Resisting force on the base [lb/ft].....: 4240.67

Safety coefficient.....: OK\* ✓  
\* Not applicable, active thrust very small

OVERTURNING

Overturning moment [lbft/ft].....: 1271.46  
Restoring moment [lbft/ft].....: 21294.74

Safety coefficient.....: 16.748 > 2.0

STRESSES ACTING ON FOUNDATION

Stress on outer foundation border [lb/ft<sup>2</sup>]....: 261.49 }  
Stress on inner foundation border [lb/ft<sup>2</sup>]....: 1537.86 }  $\approx 900 \text{ psi}$   
Max. allow. stress on the foundation [lb/ft<sup>2</sup>]..: 3000.00

Gabion Walls calculation - GAWAC BR02  
MACCAFERRI GABIONS INC. - SACRAMENTO (CA)

File: HIGAB1 Project : UMCC Upper Gabion Wall - final condition

\*\*\*\*\*  
RESULTS PAGE 4  
\*\*\*\*\*

#### OVERALL STABILITY

Initial distance at pivot leftside [ft].....:  
Initial distance at pivot rightside [ft].....:  
Initial depth referred to base [ft].....:  
Max. depth allowed in the calculation [ft].....:  
Center of the arc referred to X axis [ft].....: -3.28  
Center of the arc referred to Y axis [ft].....: 13.83  
Radius of the arc [ft].....: 17.61  
Number of search surfaces .....: 51

Safety coefficient.....: 1.592 > 1.5 ok

#### INTERNAL STABILITY

Layer	H [ft]	N [lb/ft]	T [lbft/ft]	M [lb/ft2]	tmax [lb/ft2]	tad [lb/ft2]	smax [lb/ft2]
1	5.24	2110.32	-237.07	4985.63	-79.02	1125.89	446.63
2	2.46	944.71	-124.59	1638.47	-41.53	803.81	272.35

Allowable normal pressure [lb/ft2].....: 14196.98

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#### NOTICE

##### MACCAFERRI GABIONS

is not responsible for the reliability of the geotechnical parameters assumed, nor the improper use of the software. The GAWAC program should be used only in conjunction with Maccaferri products

\*\*\*\*\* C2-20 \*\*\*\*\*

# Upper Grabin Wall

\*\*\*\*\*  
RSS  
Reinforced Slope Stability  
\*\*\*\*\*  
(c)1992-1996 by GEOCOMP Corp, Concord, MA  
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\*\*\*\*\*

File : D:\RSS\reclut2.dat

Date : Fri 08-24-1, 10:12:17

Name : Reclaimed Test Pit Slope

Problem Title : Reinforced Slope (ParaGrid 50/15 Geogrid)

Description : saturated overburden, normal in embankment

Remarks :

## INPUT DATA

### Profile Boundaries

Number of Boundaries : 33

Number of Top Boundaries : 18

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	22.50	35.50	38.00	35.50	3
2	38.00	35.50	46.90	38.60	3
3	46.90	38.60	50.00	40.20	4
4	50.00	40.20	54.80	40.20	4
5	54.80	40.20	54.90	41.20	2
6	54.90	41.20	55.00	49.80	1
7	55.00	49.80	77.50	54.80	1
8	77.50	54.80	82.30	54.80	1
9	82.30	54.80	82.50	63.80	1
10	82.50	63.80	96.90	65.00	1
11	96.90	65.00	97.90	65.00	2
12	97.90	65.00	100.30	74.30	4
13	100.30	74.30	106.30	74.30	4
14	106.30	74.30	109.40	79.10	4
15	109.40	79.10	129.40	100.60	3
16	129.40	100.60	133.50	101.30	3
17	133.50	101.30	136.50	105.00	3
18	136.50	105.00	145.00	112.50	3
19	109.40	79.10	145.00	96.00	4
20	54.90	41.20	93.00	48.00	2
21	93.00	48.00	96.90	65.00	2
22	54.80	40.20	79.50	44.50	4
23	79.50	44.50	94.00	47.00	5
24	94.00	47.00	95.90	55.30	5
25	95.90	55.30	97.90	65.00	4
26	22.50	29.10	34.10	29.50	5
27	34.10	29.50	42.00	35.10	5
28	42.00	35.10	46.90	38.60	4
29	42.00	35.10	63.00	38.80	5
30	63.00	38.80	75.90	43.50	5
31	75.90	43.50	79.50	44.50	5
32	95.90	55.30	102.60	67.60	5
33	102.60	67.60	145.00	71.70	5

**Soil Parameters**

Number of Soil Types : 5

Type	Total Unit Wt.	Saturated Unit Wt.	Cohesion	Friction Intercept	Pore Angle	Pressure Constant	Piez. Surface No.
No.	(pcf)	(pcf)	(psf)	(deg)	Param.	(psf)	
1	138.0	140.0	10.0	38.0	0.00	0.0	0
2	125.0	130.0	0.0	38.0	0.00	0.0	0
3	134.0	134.0	100.0	34.0	0.00	0.0	0
4	137.0	141.0	400.0	38.0	0.00	0.0	0
5	152.0	155.0	2080.0	38.0	0.00	0.0	0

**Boundary Loads**

Number of Loads : 2

Load No.	X-Left (ft)	X-Right (ft)	Intensity (psf)	Inclination (deg)
1	50.00	54.80	1500.0	0.0
2	77.50	82.30	1500.0	0.0

**Data for Reinforcement Analysis**

Lowest Elevation for Reinforcement : 43.80 ft

Highest Elevation for Reinforcement : 54.80 ft

Minimum Embedment Length : 3.00 ft

Strength Option : Long Term Strength

Extension Factor : 1.00

Reduction Factor : 7.00

Pulldown Factor of Safety : 2.00

Pulldown Resistance Factor : 0.54

Embedded Scale Factor : 0.67

Slope Coefficient of Friction : 0.67

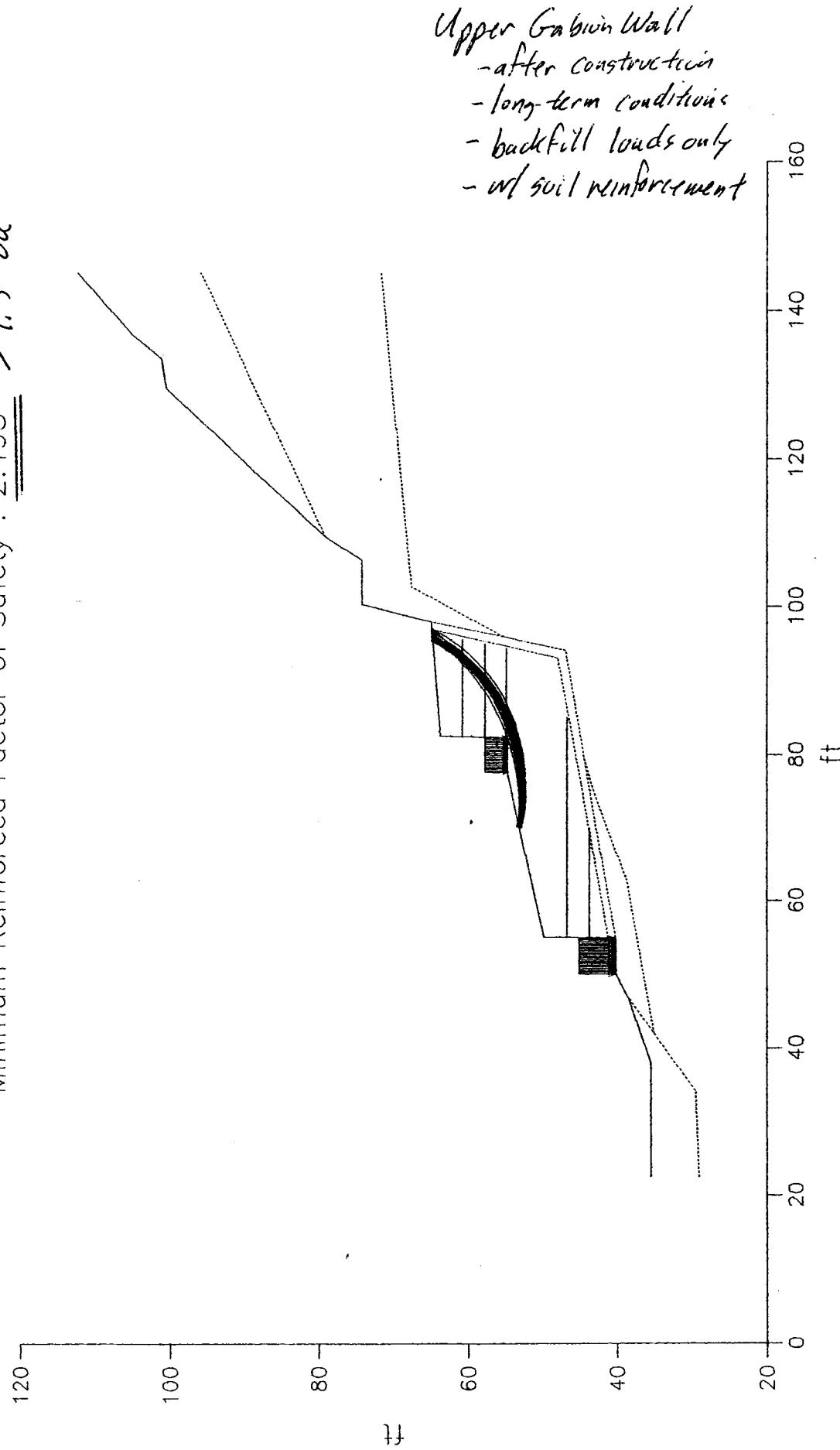
Foundation Coefficient of Friction : 0.67

Layer No	Elevation (ft)	Length (ft)	Long Term Strength (lb/ft)	Ultimate Strength (lb/ft)
1	43.80	15.00	2011.00	3425.00
2	46.80	30.00	2011.00	3425.00
3	54.90	12.00	2011.00	3425.00
4	57.80	12.50	2011.00	3425.00
5	60.80	13.00	2011.00	3425.00

Title : Reinforced Slope (ParaGrid 50/15 Geogrid)  
Description : saturated overburden, normal in embankment

Reinforcement Analysis – Most Critical Surfaces

Minimum Reinforced Factor of Safety : 2.495 > 1.5 ok



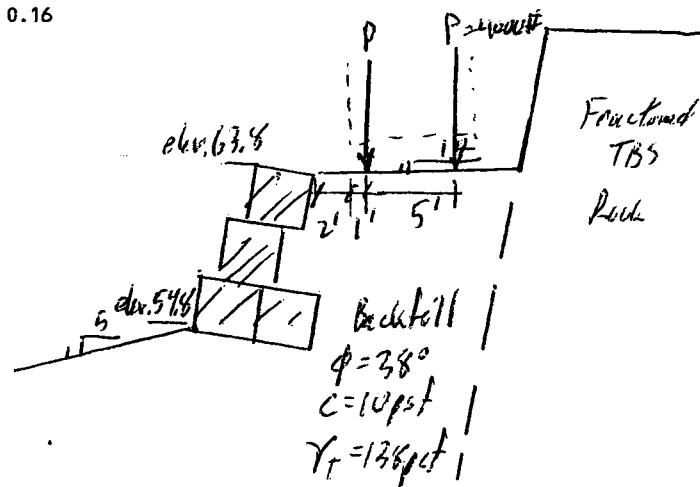
Gabion Walls calculation - GAWAC BR02  
MACCAFERRI GABIONS INC. - SACRAMENTO (CA)

File: HIGAB1 Project : UMCC Upper Gabion Wall - backfill loads

\*\*\*\*\*  
DATA INPUT PAGE 1  
\*\*\*\*\*

#### WALL DATA

Wall batter [deg]..... 10.00 Layer Length Height Init.  
Rockfill unit weight [lb/ft<sup>3</sup>] : 155.00 [ft] [ft] [ft]  
Porosity of gabions..... 0.20 -----  
Geotextile in backfill..... No 1 6.00 3.00  
Friction reduction [%]..... 2 3.00 3.00 1.00  
Geotextile under the base..... Yes 3 3.00 2.50 2.00  
Friction reduction [%]..... 0.16



#### GEOMETRICAL PARAMETERS OF BACKFILL

Inclination of the first stretch [deg]..... 4.76  
Length of the stretch [ft]..... 10.00  
Inclination of the second stretch [deg]..... 0.00

#### BACKFILL SOIL DATA

Unit weight of soil [lb/ft<sup>3</sup>]..... 138.00  
Friction angle [deg]..... 38.00  
Cohesion [lb/ft<sup>2</sup>]..... 10.00

#### BACKFILL SOIL ADDITIONAL DATA

Layer	Initial Height [ft]	Inclin. angle [deg]	Unit weight [lb/ft <sup>3</sup> ]	Cohesion [lb/ft <sup>2</sup> ]	Frict. angle [deg]
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#### Upper Gabion Wall

- during construction
- transient (short-term) load
- backfill w/eg. loads

Gabion Walls calculation - GAWAC BR02  
MACCAFERRI GABIONS INC. - SACRAMENTO (CA)

File: HIGAB1 Project : UMCC Upper Gabion Wall - backfill loads

\*\*\*\*\*  
DATA INPUT PAGE 2  
\*\*\*\*\*

DATA ABOUT THE UPHILL WATER SURFACE

Initial height [ft].....:  
Inclination of the first stretch [deg].....:  
Length of the stretch [ft].....:  
Inclination of the second stretch [deg].....:  
Length of the stretch [ft].....:

GEOMETRICAL DATA ABOUT FOUNDATION SOIL

Elev. of placing from the base [ft].....: 0.00  
Soil inclination ref.to base [deg].....: 11.30

DATA ABOUT FOUNDATION SOIL

Unit weight of soil [lb/ft<sup>3</sup>].....:138.00  
Friction angle [deg].....: 38.00  
Cohesion [lb/ft<sup>2</sup>].....: 10.00  
Allowable stress on foundation [lb/ft<sup>2</sup>].....:3000.00  
Water level [ft].....: 0.00

DATA ABOUT ADDITIONAL FOUNDATION SOILS

Layer	Depth [ft]	Unit weight [lb/ft <sup>3</sup> ]	Cohesion [lb/ft <sup>2</sup> ]	Frict.angle [deg]
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DATA ABOUT DISTRIBUTED LOADS

Distributed loads on backfill

First stretch [lb/ft<sup>2</sup>]...: Second stretch [lb/ft<sup>2</sup>]...:  
Distr. loads on the wall  
Surcharge load [lb/ft<sup>2</sup>]...:

Point loads on the backfill

1.Load [lb/ft].....:4000.00 Dist. from wall top [ft]..: 3.00  
2.Load [lb/ft].....:4000.00 Dist. from wall top [ft]..: 8.00  
3.Load [lb/ft].....: Dist. from wall top [ft]..:

Point loads on the wall

Surcharge load [lb/ft<sup>2</sup>]...: Dist. from wall top [ft]..:

DATA ABOUT SEISMIC ACTIONS

Horizontal coefficient...: Vertical coefficient....:  
C2-25

Gabion Walls calculation - GAWAC BR02  
MACCAFERRI GABIONS INC. - SACRAMENTO (CA)

File: HIGAB1 Project : UMCC Upper Gabion Wall - backfill loads

\*\*\*\*\*  
RESULTS PAGE 3  
\*\*\*\*\*

#### EXTERNAL STABILITY

Active thrust [lb/ft].....: 2570.16

Point of application ref. to X axis [ft].....: 6.07

Point of application ref. to Y axis [ft].....: 1.84

Direction of thrust ref. to X axis [deg].....: 34.71

Passive thrust [lb/ft].....: 0.00

Point of application ref. to X axis [ft].....: 0.00

Point of application ref. to Y axis [ft].....: 0.00

Direction of thrust ref. to X axis [deg].....: -11.30

#### SLIDING

Normal force on the base [lb/ft].....: 6540.15

Point of application ref. to X axis [ft].....: 3.52

Point of application ref. to Y axis [ft].....: -0.62

Shear force on the base [lb/ft].....: 992.18

Resisting force on the base [lb/ft].....: 5131.55

Safety coefficient.....: 5.172 > 1.0 OK

#### OVERTURNING

Overturning moment [lbft/ft].....: 3883.47

Restoring moment [lbft/ft].....: 26916.29

Safety coefficient.....: 6.931 > 2.0 UK

#### STRESSES ACTING ON FOUNDATION

Stress on outer foundation border [lb/ft<sup>2</sup>]....: 521.30

Stress on inner foundation border [lb/ft<sup>2</sup>]....: 1658.75

Max. allow. stress on the foundation [lb/ft<sup>2</sup>]..: 3000.00

Gabion Walls calculation - GAWAC BR02  
MACCAFERRI GABIONS INC. - SACRAMENTO (CA)

File: HIGAB1 Project : UMCC Upper Gabion Wall - backfill loads

\*\*\*\*\*  
RESULTS PAGE 4  
\*\*\*\*\*

#### OVERALL STABILITY

Initial distance at pivot leftside [ft].....:  
Initial distance at pivot rightside [ft].....:  
Initial depth referred to base [ft].....:  
Max. depth allowed in the calculation [ft]....:  
Center of the arc referred to X axis [ft].....: -3.18  
Center of the arc referred to Y axis [ft].....: 15.86  
Radius of the arc [ft].....: 19.22  
Number of search surfaces .....: 86

Safety coefficient.....: 1.205 > 1.2 OK

#### INTERNAL STABILITY

Layer	H [ft]	N [lb/ft]	T [lb/ft]	M [lbft/ft]	tmax [lb/ft2]	tad [lb/ft2]	smax [lb/ft2]
1	5.24	2341.38	203.12	5799.30	67.71	1189.74	472.65
2	2.46	944.71	-124.59	1638.47	-41.53	803.81	272.35

Allowable normal pressure [lb/ft2].....: 14196.98

#### NOTICE

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*Upper Wall  
w/ equipment loads*

\*\*\*\*\*  
\*\*\*\* R S S \*\*\*\*  
\*\*\*\* Reinforced Slope Stability \*\*\*\*  
\*\*\*\*  
\*\*\*\* (c)1992-1996 by GEOCOMP Corp, Concord, MA \*\*\*\*  
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\*\*\*\*\*

File : D:\RSS\reclut3.dat

Date : Fri 08-24-1, 10:12:17

Name : Reclaimed Test Pit Slope

Problem Title : Reinforced Slope (ParaGrid 50/15 Geogrid)

Description : saturated overburden, normal in embankment

Remarks :

\*\*\*\*\*  
\*\*\*\* INPUT DATA \*\*\*\*  
\*\*\*\*\*

Profile Boundaries

Number of Boundaries : 33

Number of Top Boundaries : 18

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	22.50	35.50	38.00	35.50	3
2	38.00	35.50	46.90	38.60	3
3	46.90	38.60	50.00	40.20	4
4	50.00	40.20	54.80	40.20	4
5	54.80	40.20	54.90	41.20	2
6	54.90	41.20	55.00	49.80	1
7	55.00	49.80	77.50	54.80	1
8	77.50	54.80	82.30	54.80	1
9	82.30	54.80	82.50	63.80	1
10	82.50	63.80	96.90	65.00	1
11	96.90	65.00	97.90	65.00	2
12	97.90	65.00	100.30	74.30	4
13	100.30	74.30	106.30	74.30	4
14	106.30	74.30	109.40	79.10	4
15	109.40	79.10	129.40	100.60	3
16	129.40	100.60	133.50	101.30	3
17	133.50	101.30	136.50	105.00	3
18	136.50	105.00	145.00	112.50	3
19	109.40	79.10	145.00	96.00	4
20	54.90	41.20	93.00	48.00	2
21	93.00	48.00	96.90	65.00	2
22	54.80	40.20	79.50	44.50	4
23	79.50	44.50	94.00	47.00	5
24	94.00	47.00	95.90	55.30	5
25	95.90	55.30	97.90	65.00	4
26	22.50	29.10	34.10	29.50	5
27	34.10	29.50	42.00	35.10	5
28	42.00	35.10	46.90	38.60	4
29	42.00	35.10	63.00	38.80	5
30	63.00	38.80	75.90	43.50	5
31	75.90	43.50	79.50	44.50	5
32	95.90	55.30	102.60	67.60	5
33	102.60	67.60	145.00	71.70	5

**Soil Parameters**

Number of Soil Types : 5

Type	Total Wt.	Saturated Wt.	Cohesion	Friction Angle	Pore Pressure	Piez. Constant	Surface No.
No.	(pcf)	(pcf)	(psf)	(deg)	Param.	(psf)	No.
1	138.0	140.0	10.0	38.0	0.00	0.0	0
2	125.0	130.0	0.0	38.0	0.00	0.0	0
3	134.0	134.0	100.0	34.0	0.00	0.0	0
4	137.0	141.0	400.0	38.0	0.00	0.0	0
5	152.0	155.0	2080.0	38.0	0.00	0.0	0

**Boundary Loads**

Number of Loads : 4

Load No.	X-Left (ft)	X-Right (ft)	Intensity (psf)	Inclination (deg)
1	50.00	54.80	1500.0	0.0
2	77.50	82.30	1500.0	0.0
3	84.58	86.42	2170.0	0.0
4	89.58	91.42	2170.0	0.0

**Data for Reinforcement Analysis**

Lowest Elevation for Reinforcement : 43.80 ft

Highest Elevation for Reinforcement : 54.80 ft

Minimum Embedment Length : 3.00 ft

Strength Option : Long Term Strength

Extension Factor : 1.00

Reduction Factor : 7.00

PULLOUT Factor of Safety : 2.00

PULLOUT Resistance Factor : 0.54

Embedded Scale Factor : 0.67

Slope Coefficient of Friction : 0.67

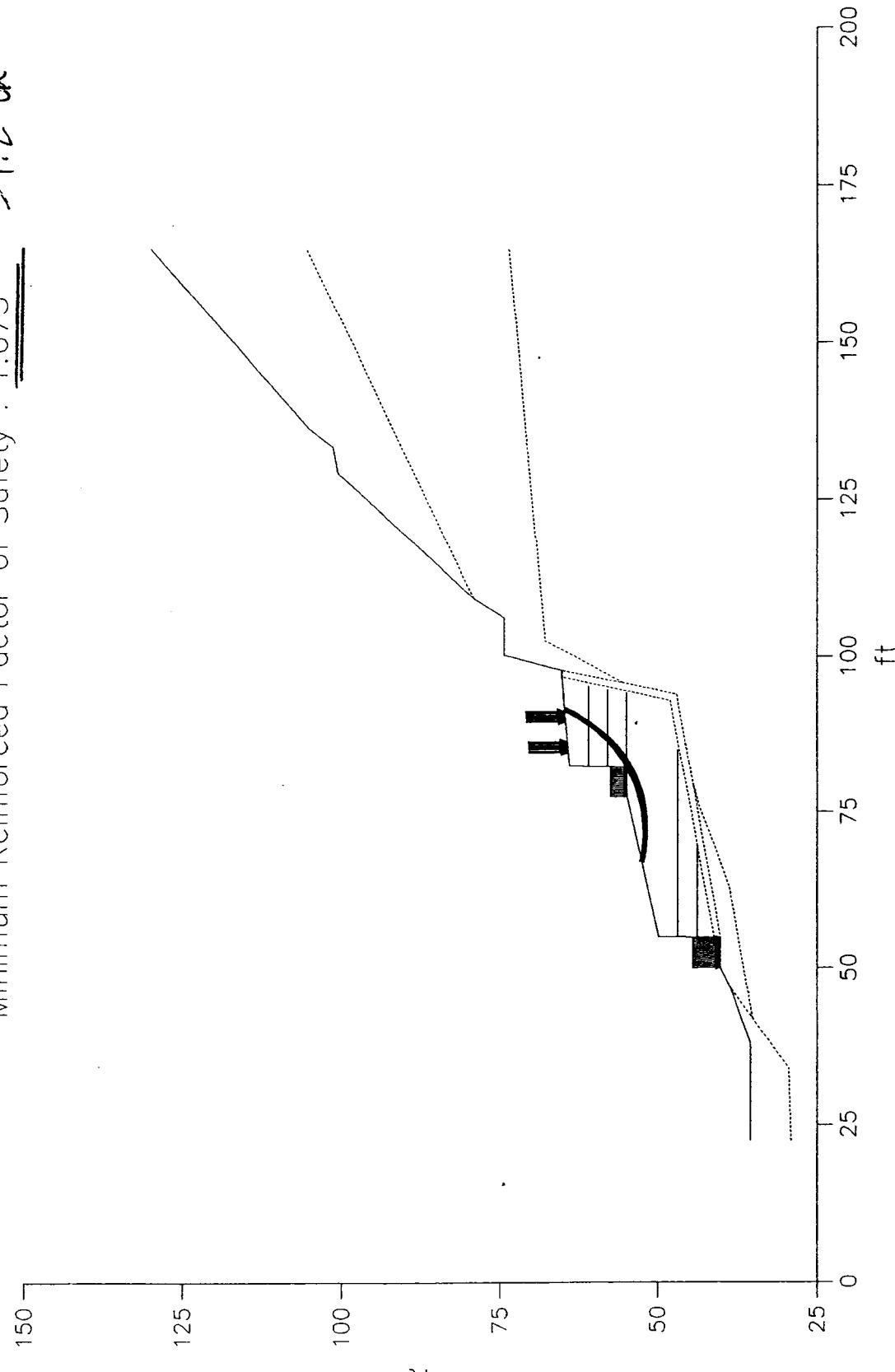
Foundation Coefficient of Friction : 0.67

Layer No	Elevation (ft)	Length (ft)	Long Term Strength (lb/ft)	Ultimate Strength (lb/ft)
1	43.80	15.00	2011.00	3425.00
2	46.80	30.00	2011.00	3425.00
3	54.90	12.00	2011.00	3425.00
4	57.80	12.50	2011.00	3425.00
5	60.80	13.00	2011.00	3425.00

Title : Reinforced Slope (ParaGrid 50/15 Geogrid)  
Description : saturated overburden, normal in embankment

Reinforcement Analysis - Most Critical Surfaces

Minimum Reinforced Factor of Safety : 1.675  $\rightarrow 1.2 \text{ ok}$



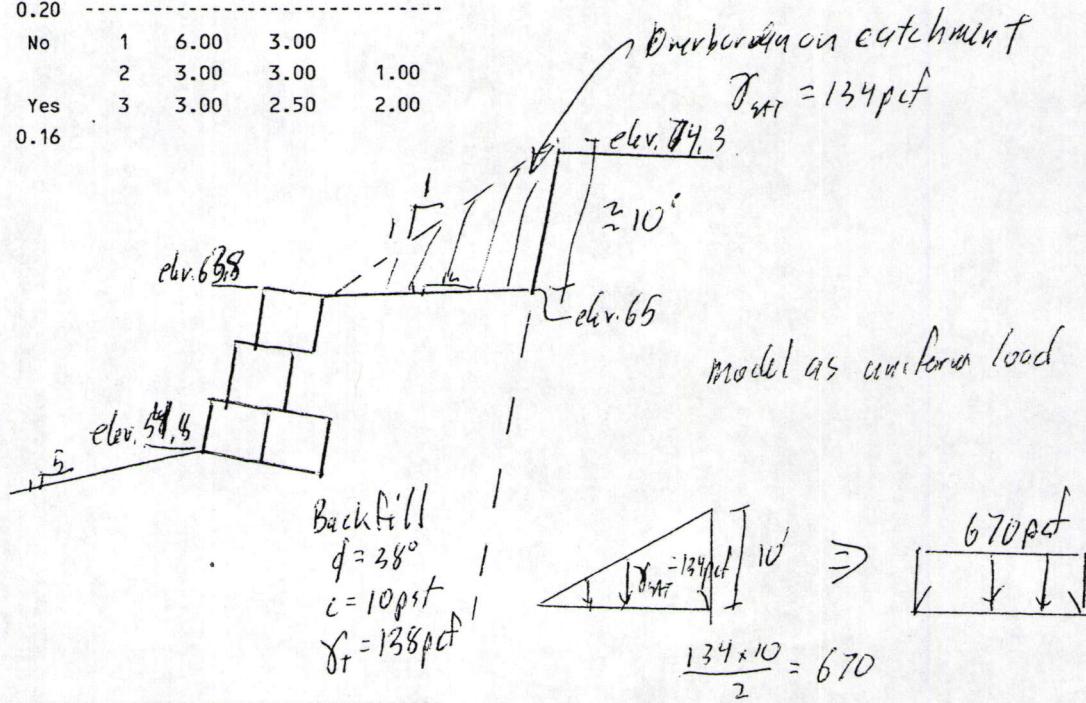
File: HIGAB3 Project : UMCC Upper Gabion Wall - catchment loads

Upper Gabion Wall  
- after construction  
- overburden failure load

\*\*\*\*\*  
DATA INPUT PAGE 1  
\*\*\*\*\*

#### WALL DATA

Wall batter [deg].....	10.00	Layer	Length	Height	Init.
Rockfill unit weight [lb/ft <sup>3</sup> ].....	155.00		[ft]	[ft]	[ft]
Porosity of gabions.....	0.20	-----			
Geotextile in backfill.....	No	1	6.00	3.00	
Friction reduction [%].....		2	3.00	3.00	1.00
Geotextile under the base.....	Yes	3	3.00	2.50	2.00
Friction reduction [%].....	0.16				



#### GEOMETRICAL PARAMETERS OF BACKFILL

Inclination of the first stretch [deg].....: 4.76  
Length of the stretch [ft].....: 10.00  
Inclination of the second stretch [deg].....: 0.00

#### BACKFILL SOIL DATA

Unit weight of soil [lb/ft<sup>3</sup>].....: 138.00  
Friction angle [deg].....: 38.00  
Cohesion [lb/ft<sup>2</sup>].....: 10.00

#### BACKFILL SOIL ADDITIONAL DATA

Layer	Initial Height [ft]	Inclin. angle [deg]	Unit weight [lb/ft <sup>3</sup> ]	Cohesion [lb/ft <sup>2</sup> ]	Frict. angle [deg]
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Gabion Walls calculation - GAWAC BRO2  
MACCAFERRI GABIONS INC. - SACRAMENTO (CA)

File: HIGAB3 Project : UMCC Upper Gabion Wall - catchment loads

\*\*\*\*\*  
DATA INPUT PAGE 2  
\*\*\*\*\*

DATA ABOUT THE UPHILL WATER SURFACE

Initial height [ft].....:  
Inclination of the first stretch [deg].....:  
Length of the stretch [ft].....:  
Inclination of the second stretch [deg].....:  
Length of the stretch [ft].....:

GEOMETRICAL DATA ABOUT FOUNDATION SOIL

Elev. of placing from the base [ft].....: 0.00  
Soil inclination ref.to base [deg].....: 11.30

DATA ABOUT FOUNDATION SOIL

Unit weight of soil [lb/ft<sup>3</sup>].....:138.00  
Friction angle [deg].....: 38.00  
Cohesion [lb/ft<sup>2</sup>].....: 10.00  
Allowable stress on foundation [lb/ft<sup>2</sup>].....:3000.00  
Water level [ft].....: 0.00

DATA ABOUT ADDITIONAL FOUNDATION SOILS

Layer	Depth [ft]	Unit weight [lb/ft <sup>3</sup> ]	Cohesion [lb/ft <sup>2</sup> ]	Frict.angle [deg]
-----	-----	-----	-----	-----

DATA ABOUT DISTRIBUTED LOADS

Distributed loads on backfill  
First stretch [lb/ft<sup>2</sup>]...:670.00 Second stretch [lb/ft<sup>2</sup>]...:  
Distr. loads on the wall  
Surcharge load [lb/ft<sup>2</sup>]...:

Point loads on the backfill  
1.Load [lb/ft].....: Dist. from wall top [ft]..  
2.Load [lb/ft].....: Dist. from wall top [ft]..  
3.Load [lb/ft].....: Dist. from wall top [ft]..  
Point loads on the wall  
Surcharge load [lb/ft<sup>2</sup>]...: Dist. from wall top [ft]..

DATA ABOUT SEISMIC ACTIONS

Horizontal coefficient...: Vertical coefficient....:  
C2-32

Gabion Walls calculation - GAWAC BR02  
MACCAFERRI GABIONS INC. - SACRAMENTO (CA)

File: HIGAB3 Project : UMCC Upper Gabion Wall - catchment loads

\*\*\*\*\*  
RESULTS PAGE 3  
\*\*\*\*\*

#### EXTERNAL STABILITY

Active thrust [lb/ft].....: 2156.18  
Point of application ref. to X axis [ft].....: 6.11  
Point of application ref. to Y axis [ft].....: 2.53  
Direction of thrust ref. to X axis [deg].....: 34.71

Passive thrust [lb/ft].....: 0.00  
Point of application ref. to X axis [ft].....: 0.00  
Point of application ref. to Y axis [ft].....: 0.00  
Direction of thrust ref. to X axis [deg].....: -11.30

#### SLIDING

Normal force on the base [lb/ft].....: 6248.91  
Point of application ref. to X axis [ft].....: 3.37  
Point of application ref. to Y axis [ft].....: -0.59  
Shear force on the base [lb/ft].....: 697.97  
Resisting force on the base [lb/ft].....: 4904.37

Safety coefficient.....: 7.027 *> 1.5 ok*

#### OVERTURNING

Overturning moment [lbft/ft].....: 4483.13  
Restoring moment [lbft/ft].....: 25533.17

Safety coefficient.....: 5.695 *> 2.0 ok*

#### STRESSES ACTING ON FOUNDATION

Stress on outer foundation border [lb/ft<sup>2</sup>]....: 657.60  
Stress on inner foundation border [lb/ft<sup>2</sup>]....: 1425.37  
Max. allow. stress on the foundation [lb/ft<sup>2</sup>]..: 3000.00

Gabion Walls calculation - GAWAC BR02  
MACCAFERRI GABIONS INC. - SACRAMENTO (CA)

File: HIGAB3 Project : UMCC Upper Gabion Wall - catchment loads

\*\*\*\*\*  
RESULTS PAGE 4  
\*\*\*\*\*

#### OVERALL STABILITY

Initial distance at pivot leftside [ft].....:  
Initial distance at pivot rightside [ft].....:  
Initial depth referred to base [ft].....:  
Max. depth allowed in the calculation [ft]....:  
Center of the arc referred to X axis [ft].....: -2.72  
Center of the arc referred to Y axis [ft].....: 13.97  
Radius of the arc [ft].....: 17.32  
Number of search surfaces .....: 60  
  
Safety coefficient.....: 1.313

$\geq 1.5$  - need soil reinforcement

#### INTERNAL STABILITY

Layer	H [ft]	N [lb/ft]	T [lbft/ft]	M [lb/ft2]	tmax [lb/ft2]	tad [lb/ft2]	smax [lb/ft2]
1	5.24	2282.01	90.01	4687.06	30.00	1173.33	555.53
2	2.46	1110.04	87.03	1869.95	29.01	849.50	329.47

Allowable normal pressure [lb/ft2].....: 14196.98

\*\*\*\*\*

#### NOTICE

##### MACCAFERRI GABIONS

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\*\*\*\*\* C2-34 \*\*\*\*\*

*Upper Wall  
w/ overburden  
catchment  
Loads*

\*\*\*\*\*  
 \*\*\*\* R S S \*\*\*\*  
 \*\*\*\* Reinforced Slope Stability \*\*\*\*  
 \*\*\*\*  
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 \*\*\*\*\*

File : D:\RSS\reclut5.dat

Date : Fri 08-24-1, 10:12:17

Name : Reclaimed Test Pit Slope

Problem Title : Reinforced Slope (ParaGrid 50/15 Geogrid)

Description : saturated overburden, normal in embankment

Remarks :

\*\*\*\*\*  
 \*\*\*\* INPUT DATA \*\*\*\*  
 \*\*\*\*\*

Profile Boundaries

Number of Boundaries : 33

Number of Top Boundaries : 18

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	22.50	35.50	38.00	35.50	3
2	38.00	35.50	46.90	38.60	3
3	46.90	38.60	50.00	40.20	4
4	50.00	40.20	54.80	40.20	4
5	54.80	40.20	54.90	41.20	2
6	54.90	41.20	55.00	49.80	1
7	55.00	49.80	77.50	54.80	1
8	77.50	54.80	82.30	54.80	1
9	82.30	54.80	82.50	63.80	1
10	82.50	63.80	96.90	65.00	1
11	96.90	65.00	97.90	65.00	2
12	97.90	65.00	100.30	74.30	4
13	100.30	74.30	106.30	74.30	4
14	106.30	74.30	109.40	79.10	4
15	109.40	79.10	129.40	100.60	3
16	129.40	100.60	133.50	101.30	3
17	133.50	101.30	136.50	105.00	3
18	136.50	105.00	145.00	112.50	3
19	109.40	79.10	145.00	96.00	4
20	54.90	41.20	93.00	48.00	2
21	93.00	48.00	96.90	65.00	2
22	54.80	40.20	79.50	44.50	4
23	79.50	44.50	94.00	47.00	5
24	94.00	47.00	95.90	55.30	5
25	95.90	55.30	97.90	65.00	4
26	22.50	29.10	34.10	29.50	5
27	34.10	29.50	42.00	35.10	5
28	42.00	35.10	46.90	38.60	4
29	42.00	35.10	63.00	38.80	5
30	63.00	38.80	75.90	43.50	5
31	75.90	43.50	79.50	44.50	5
32	95.90	55.30	102.60	67.60	5
33	102.60	67.60	145.00	71.70	5

### Soil Parameters

Number of Soil Types : 5

Type	Total Unit Wt.	Saturated Unit Wt.	Cohesion	Friction Intercept	Pore Angle	Pressure Constant	Piez. Surface
No.	(pcf)	(pcf)	(psf)	(deg)	Param.	(psf)	No.
1	138.0	140.0	10.0	38.0	0.00	0.0	0
2	125.0	130.0	0.0	38.0	0.00	0.0	0
3	134.0	134.0	100.0	34.0	0.00	0.0	0
4	137.0	141.0	400.0	38.0	0.00	0.0	0
5	152.0	155.0	2080.0	38.0	0.00	0.0	0

### Boundary Loads

Number of Loads : 3

Load No.	X-Left (ft)	X-Right (ft)	Intensity (psf)	Inclination (deg)
1	50.00	54.80	1500.0	0.0
2	77.50	82.30	1500.0	0.0
3	82.50	97.90	670.0	0.0

### Data for Reinforcement Analysis

Lowest Elevation for Reinforcement : 43.80 ft

Highest Elevation for Reinforcement : 54.80 ft

Minimum Embedment Length : 3.00 ft

Strength Option : Long Term Strength

Extension Factor : 1.00

Reduction Factor : 7.00

Pullout Factor of Safety : 2.00

Pullout Resistance Factor : 0.54

Embedded Scale Factor : 0.67

Slope Coefficient of Friction : 0.67

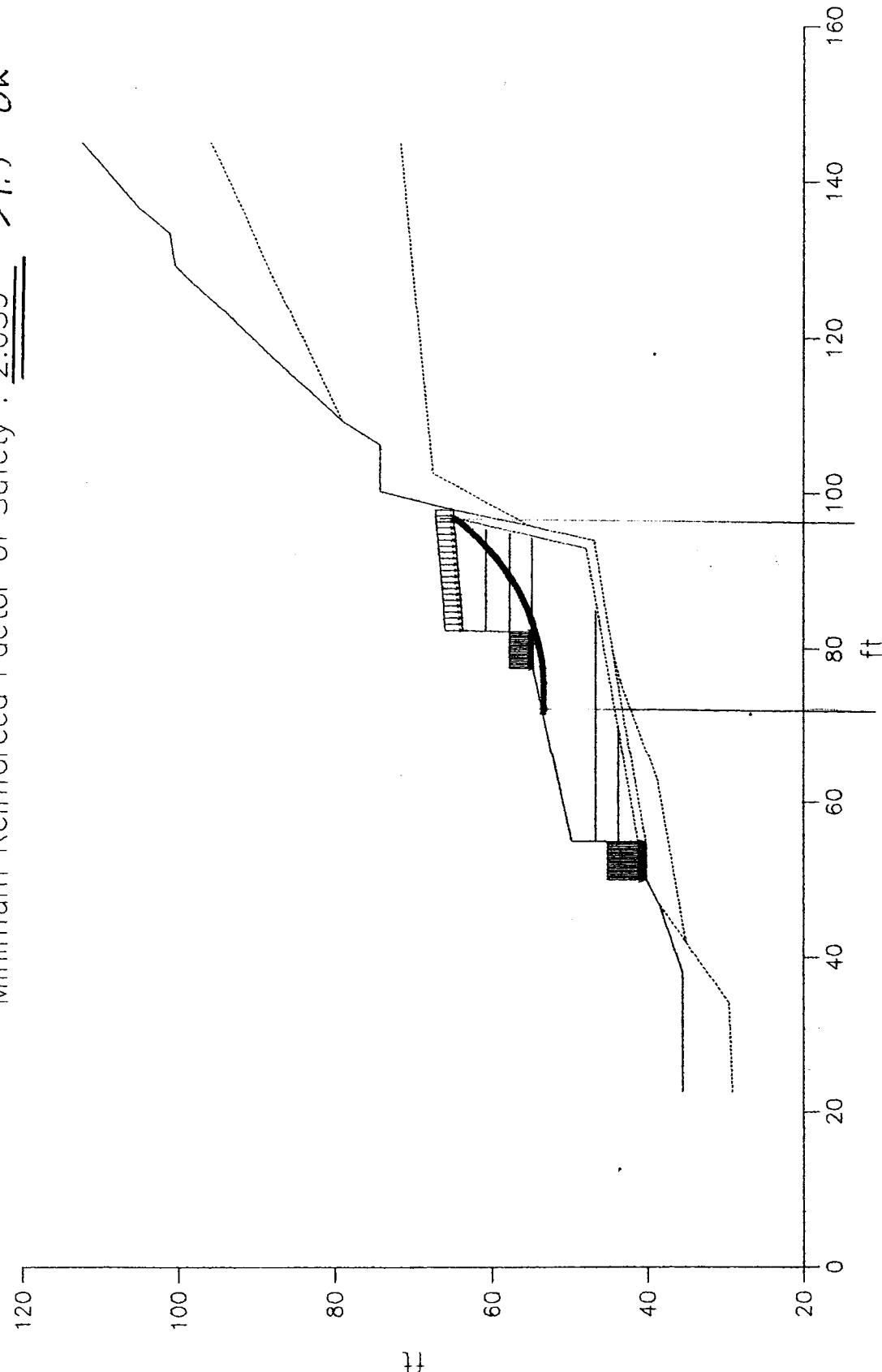
Foundation Coefficient of Friction : 0.67

Layer No.	Elevation (ft)	Length (ft)	Long Term Strength (lb/ft)	Ultimate Strength (lb/ft)
1	43.80	15.00	2011.00	3425.00
2	46.80	30.00	2011.00	3425.00
3	54.90	12.00	2011.00	3425.00
4	57.80	12.50	2011.00	3425.00
5	60.80	13.00	2011.00	3425.00

Title : Reinforced Slope (ParaGrid 50/15 Geogrid)  
Description : saturated overburden, normal in embankment

Reinforcement Analysis - Most Critical Surfaces

Minimum Reinforced Factor of Safety : 2.039  $> 1.5 \text{ ok}$



Existing Slope

(a) - deep seated failure

(b) - near surface failure  
in up-slope overburden

\*\*\*\*\* RSS \*\*\*\*\*  
\*\*\*\*\* Reinforced Slope Stability \*\*\*\*\*  
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File : D:RSS\exist1.dat

Date : Fri 08-24-1, 09:43:36

Name : Existing Test Pit Area

Problem Title : Upper Slope Stability

Description : saturated overburden

Remarks :

\*\*\*\*\* INPUT DATA \*\*\*\*\*

#### Profile Boundaries

Number of Boundaries : 30

Number of Top Boundaries : 16

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	22.50	35.50	38.00	35.50	1
2	38.00	35.50	46.90	38.60	1
3	46.90	38.60	50.00	40.20	2
4	50.00	40.20	54.00	47.30	2
5	54.00	47.30	55.00	49.20	1
6	55.00	49.20	56.40	50.40	1
7	56.40	50.40	74.50	53.00	1
8	74.50	53.00	75.60	55.00	1
9	75.60	55.00	90.30	65.00	1
10	90.30	65.00	102.60	84.50	1
11	102.60	84.50	112.20	85.00	1
12	112.20	85.00	125.70	100.00	1
13	125.70	100.00	133.50	101.30	1
14	133.50	101.30	136.50	105.00	1
15	136.50	105.00	145.00	112.50	1
16	145.00	112.50	165.00	130.00	1
17	109.40	79.10	165.00	105.50	2
18	54.00	47.30	74.50	53.00	2
19	74.50	53.00	93.10	61.50	2
20	93.10	61.50	100.30	74.30	2
21	100.30	74.30	109.40	79.10	2
22	109.40	79.10	165.00	105.50	2
23	22.50	29.10	34.10	29.50	3
24	34.10	29.50	42.00	35.10	3
25	42.00	35.10	46.90	38.60	2
26	42.00	35.10	63.00	38.80	3
27	63.00	38.80	75.90	43.50	3
28	75.90	43.50	95.90	55.30	3
29	95.90	55.30	102.60	67.60	3
30	102.60	67.60	165.00	73.60	3

#### Soil Parameters

Number of Soil Types : 3

Soil Total Saturated Cohesion Friction Pore Pressure Piez.  
Type Unit Wt. Unit Wt. Intercept Angle Pressure Constant Surface  
No. (pcf) (pcf) (psf) (deg) Param. (psf) No.

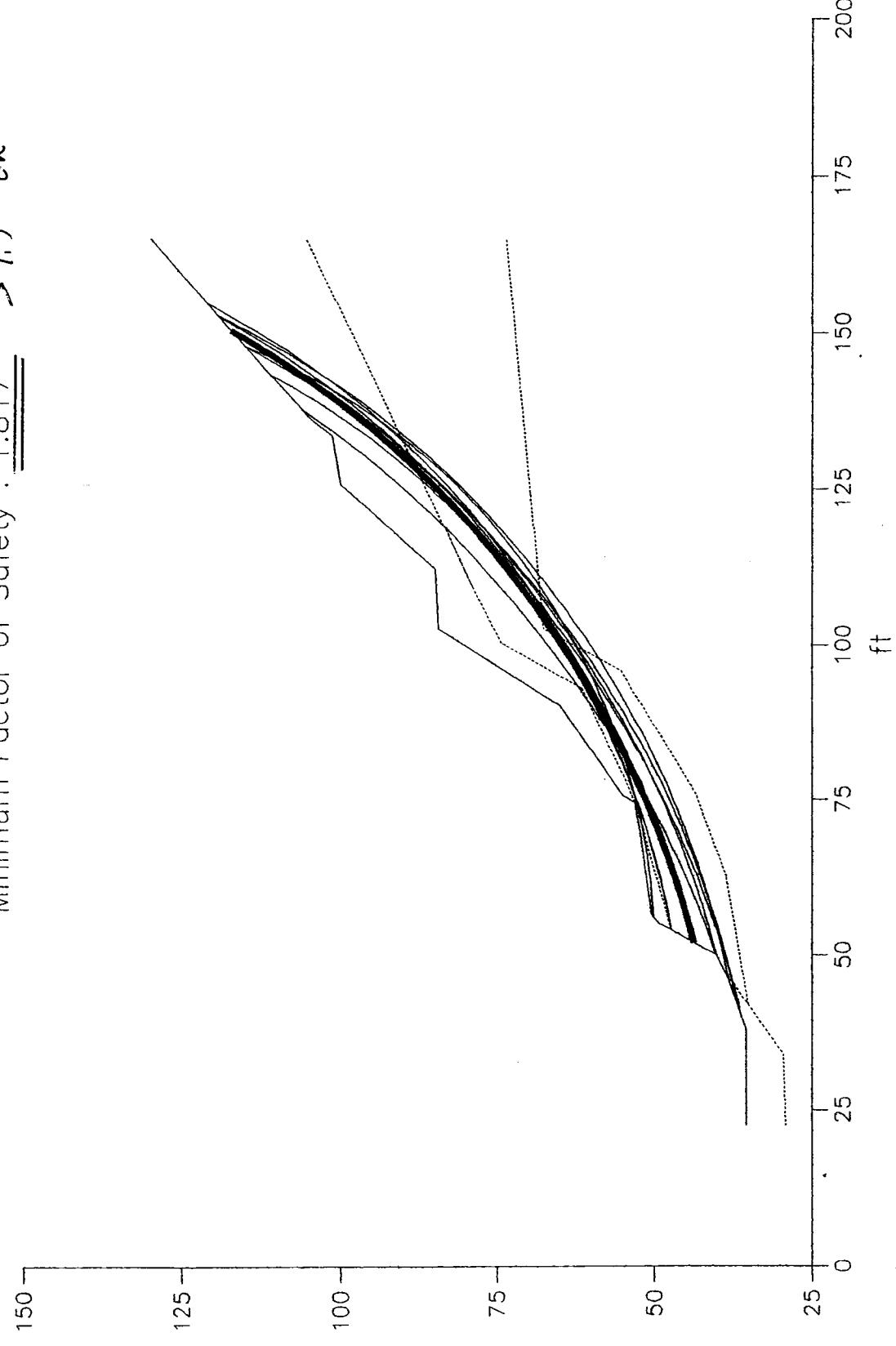
1	134.0	134.0	100.0	34.0	0.00	0.0	0	- saturated overburden
2	137.0	141.0	400.0	38.0	0.00	0.0	0	
3	152.0	155.0	2080.0	38.0	0.00	0.0	0	

Title : Upper Slope Stability  
Description : saturated overburden

(a) Deep Seated Failure

Bishop Circular Surfaces - Most Critical Surfaces

Minimum Factor of Safety : 1.817 > 1.5 ok

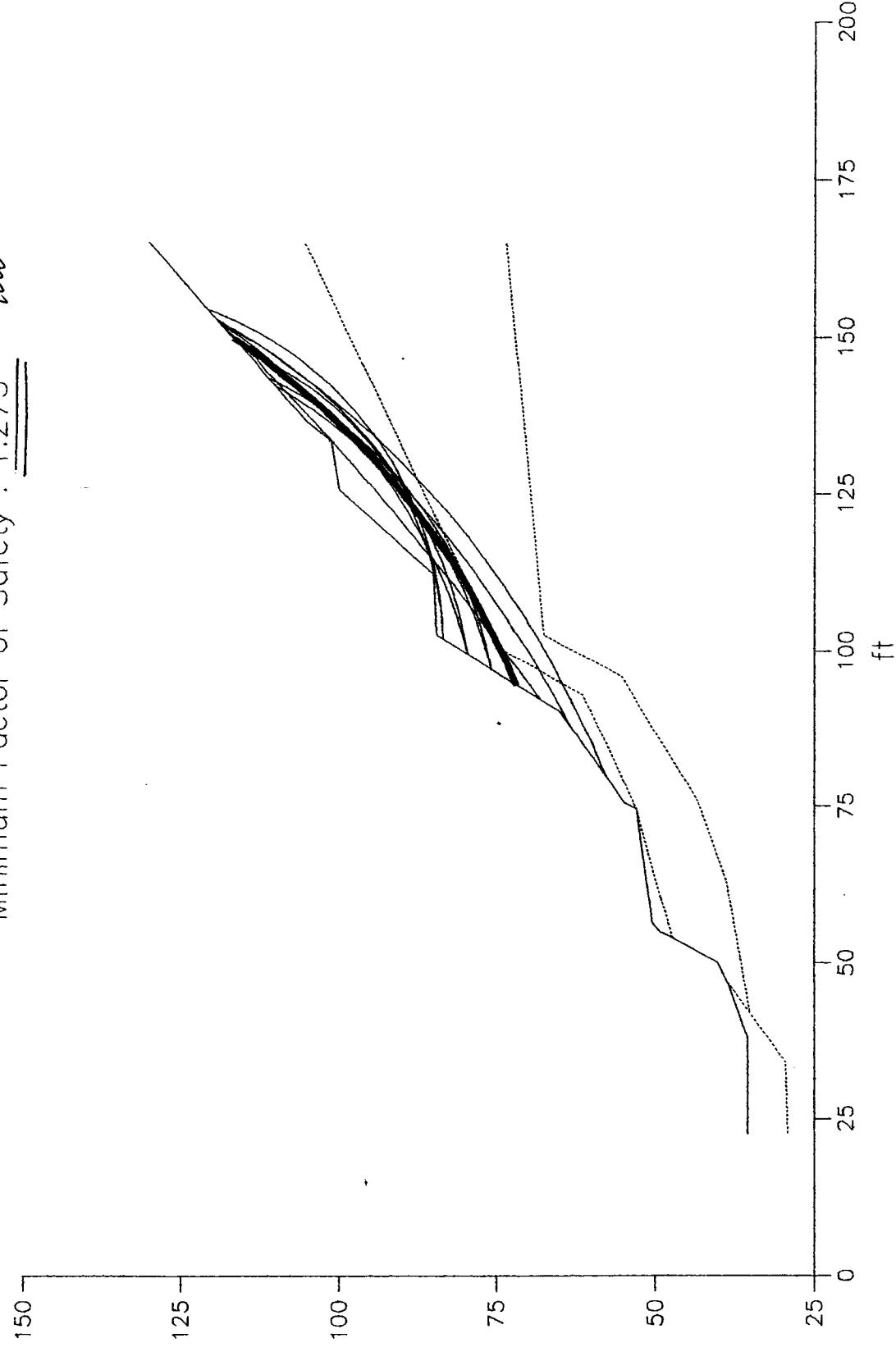


Title : Upper Slope Stability  
Description : saturated overburden

(b) Near Surface Failure

Bishop Circular Surfaces - Most Critical Surfaces

Minimum Factor of Safety : 1.275      low



# Cut Pit Slope

- (a) deep seated failure  
 (b) near surface failure  
 (in upslope overburden)

```
*****
      R S S
*****
      Reinforced Slope Stability
*****
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*****
```

File : D:\RSS\cut1.dat

Date : Fri 08-24-1, 10:02:54

Name : Excavated Test Pit

Problem Title : Upper Slope above pit

Description : saturated overburden

Remarks :

## \*\*\*\*\* INPUT DATA \*\*\*\*\*

### Profile Boundaries

Number of Boundaries : 24

Number of Top Boundaries : 15

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	22.50	35.50	38.00	35.50	3
2	38.00	35.50	46.90	38.60	3
3	46.90	38.60	50.00	40.20	4
4	50.00	40.20	54.80	40.20	4
5	54.80	40.20	79.50	44.50	4
6	79.50	44.50	94.00	47.00	5
7	94.00	47.00	95.90	55.30	5
8	95.90	55.30	100.30	74.30	4
9	100.30	74.30	106.30	74.30	4
10	106.30	74.30	109.40	79.10	4
11	109.40	79.10	129.40	100.60	3
12	129.40	100.60	133.50	101.30	3
13	133.50	101.30	136.50	105.00	3
14	136.50	105.00	145.00	112.50	3
15	145.00	112.50	165.00	130.00	3
16	109.40	79.10	165.00	105.50	4
17	22.50	29.10	34.10	29.50	5
18	34.10	29.50	42.00	35.10	5
19	42.00	35.10	46.90	38.60	4
20	42.00	35.10	63.00	38.80	5
21	63.00	38.80	75.90	43.50	5
22	75.90	43.50	79.50	44.50	5
23	95.90	55.30	102.60	67.60	5
24	102.60	67.60	165.00	73.60	5

### Soil Parameters

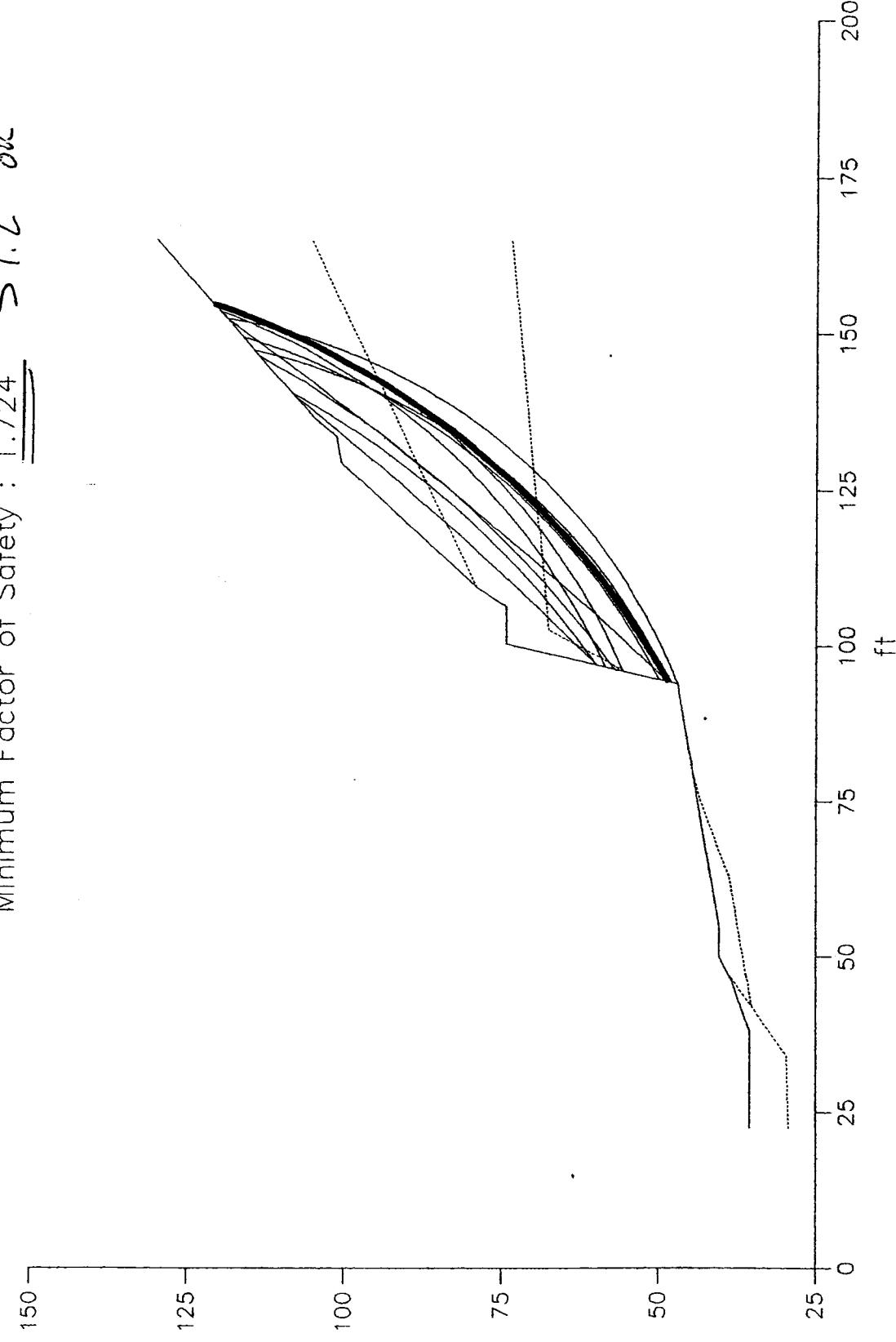
Number of Soil Types : 3

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion (psf)	Friction Intercept (deg)	Pore Pressure Angle (deg)	Pressure Constant Param.	Piez. Surface No.
1	138.0	140.0	10.0	38.0	0.00	0.0	0
2	125.0	130.0	0.0	38.0	0.00	0.0	0
3	134.0	134.0	100.0	34.0	0.00	0.0	0
4	137.0	141.0	400.0	38.0	0.00	0.0	0
5	152.0	155.0	2080.0	38.0	0.00	0.0	0

Title : Deep Seated Failure Analysis  
Description : saturated overburden

Bishop Circular Surfaces - Most Critical Surfaces

Minimum Factor of Safety : 1.724  $\rightarrow$  1.2 out

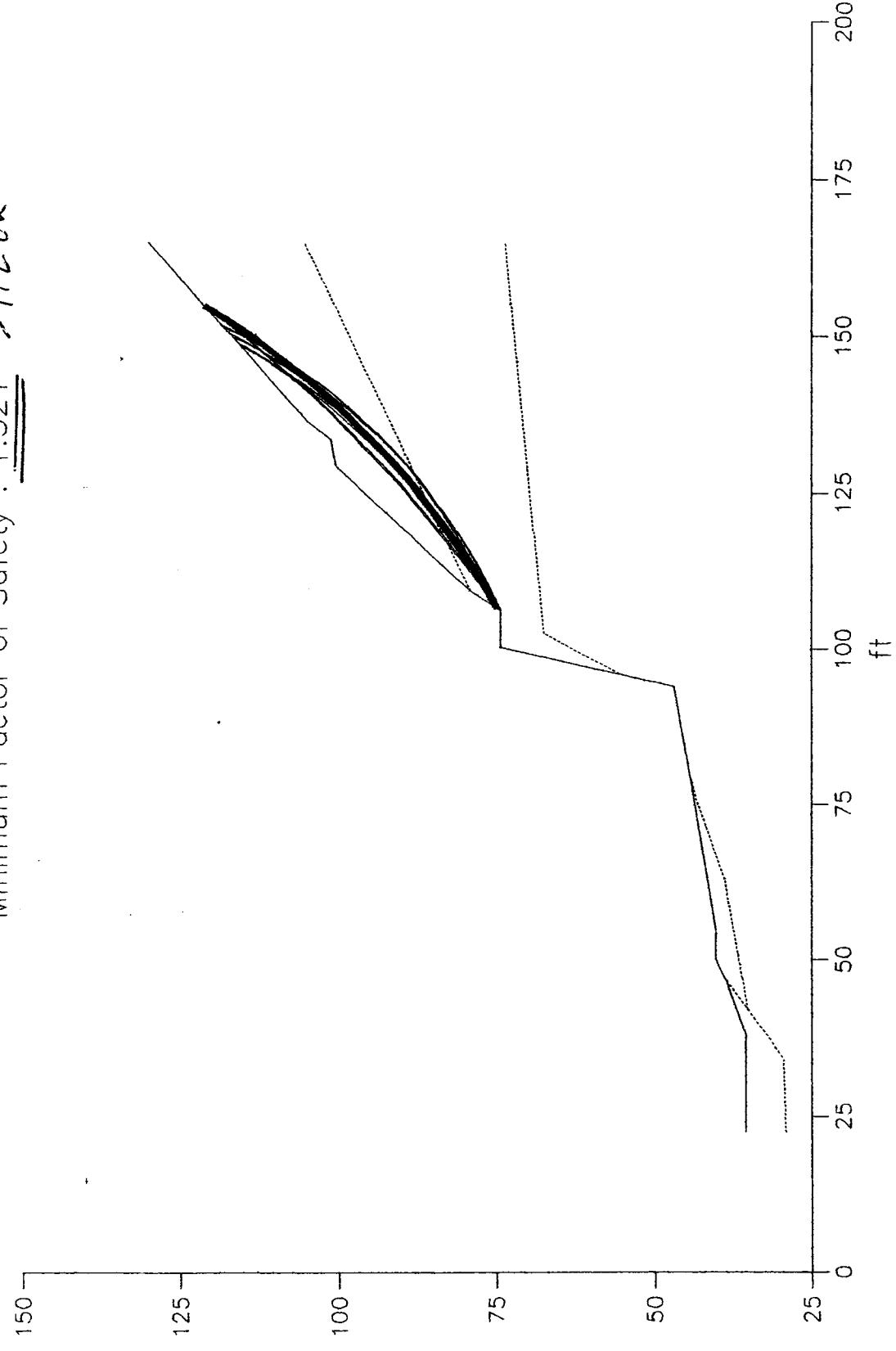


Title : Upper Slope above pit  
Description : saturated overburden

(b) Near Surface Failure

Bishop Circular Surfaces - Most Critical Surfaces

Minimum Factor of Safety : 1.321 > 1.2 ok



# Reclaimed Slope

\*\*\*\*\*
 \*\*\*\* R S S \*\*\*\*
 \*\*\*\* Reinforced Slope Stability \*\*\*\*
 \*\*\*\*
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 \*\*\*\*\*

File : D:\RSS\reclut4.dat

Date : Fri 08-24-1, 10:12:17

Name : Reclaimed Test Pit Slope

Problem Title : Reinforced Slope (ParaGrid 50/15 Geogrid)

Description : saturated overburden, normal in embankment

Remarks :

\*\*\*\*\*  
\*\*\*\* INPUT DATA \*\*\*\*  
\*\*\*\*\*

Profile Boundaries

Number of Boundaries : 33

Number of Top Boundaries : 18

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	22.50	35.50	38.00	35.50	3
2	38.00	35.50	46.90	38.60	3
3	46.90	38.60	50.00	40.20	4
4	50.00	40.20	54.80	40.20	4
5	54.80	40.20	54.90	41.20	2
6	54.90	41.20	55.00	49.80	1
7	55.00	49.80	77.50	54.80	1
8	77.50	54.80	82.30	54.80	1
9	82.30	54.80	82.50	63.80	1
10	82.50	63.80	96.90	65.00	1
11	96.90	65.00	97.90	65.00	2
12	97.90	65.00	100.30	74.30	4
13	100.30	74.30	106.30	74.30	4
14	106.30	74.30	109.40	79.10	4
15	109.40	79.10	129.40	100.60	3
16	129.40	100.60	133.50	101.30	3
17	133.50	101.30	136.50	105.00	3
18	136.50	105.00	145.00	112.50	3
19	109.40	79.10	145.00	96.00	4
20	54.90	41.20	93.00	48.00	2
21	93.00	48.00	96.90	65.00	2
22	54.80	40.20	79.50	44.50	4
23	79.50	44.50	94.00	47.00	5
24	94.00	47.00	95.90	55.30	5
25	95.90	55.30	97.90	65.00	4
26	22.50	29.10	34.10	29.50	5
27	34.10	29.50	42.00	35.10	5
28	42.00	35.10	46.90	38.60	4
29	42.00	35.10	63.00	38.80	5
30	63.00	38.80	75.90	43.50	5
31	75.90	43.50	79.50	44.50	5
32	95.90	55.30	102.60	67.60	5
33	102.60	67.60	145.00	71.70	5

- (a) Deep Slated Failure w/out soil reinforcement
- (b) Deep Slated Failure w/ soil reinforcement
- (c) Buckfill Failure w/out soil reinforcement
- (d) Buckfill Failure w/ soil reinforcement

**Soil Parameters**

Number of Soil Types : 5

Type	Total Unit Wt.	Saturated Unit Wt.	Cohesion (psf)	Friction Intercept (deg)	Pore Pressure Constant (psf)	Pressure Surface Param.	Piez. No.
1	138.0	140.0	10.0	38.0	0.00	0.0	0
2	125.0	130.0	0.0	38.0	0.00	0.0	0
3	134.0	134.0	100.0	34.0	0.00	0.0	0
4	137.0	141.0	400.0	38.0	0.00	0.0	0
5	152.0	155.0	2080.0	38.0	0.00	0.0	0

**Boundary Loads**

Number of Loads : 2

Load No.	X-Left (ft)	X-Right (ft)	Intensity (psf)	Inclination (deg)
1	50.00	54.80	1500.0	0.0
2	77.50	82.30	1500.0	0.0

**Data for Reinforcement Analysis**

Lowest Elevation for Reinforcement : 43.80 ft  
 Highest Elevation for Reinforcement : 54.80 ft  
 Minimum Embedment Length : 3.00 ft  
 Strength Option : Long Term Strength  
 Extension Factor : 1.00  
 Reduction Factor : 7.00  
 Pullout Factor of Safety : 2.00  
 Pullout Resistance Factor : 0.54  
 Embedded Scale Factor : 0.67  
 Slope Coefficient of Friction : 0.67  
 Foundation Coefficient of Friction : 0.67

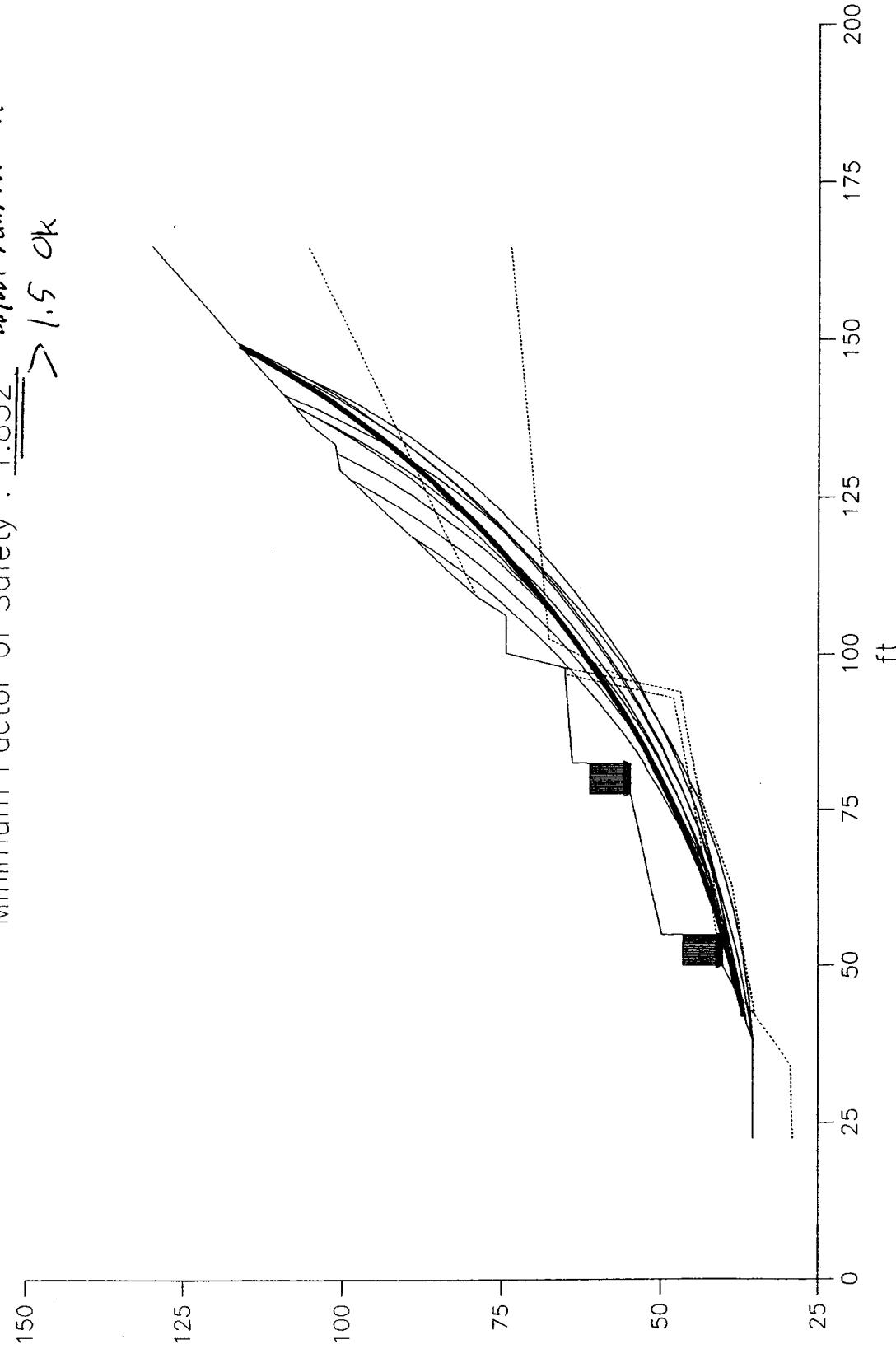
Layer No.	Elevation (ft)	Length (ft)	Long Term Strength (lb/ft)	Ultimate Strength (lb/ft)
1	43.80	15.00	2011.00	3425.00
2	46.80	30.00	2011.00	3425.00
3	54.90	12.00	2011.00	3425.00
4	57.80	12.50	2011.00	3425.00
5	60.80	13.00	2011.00	3425.00

Title : Reinforced Slope (ParaGrid 50/15 Geogrid)  
Description : saturated overburden, normal in embankment

Bishop Circular Surfaces - Most Critical Surfaces

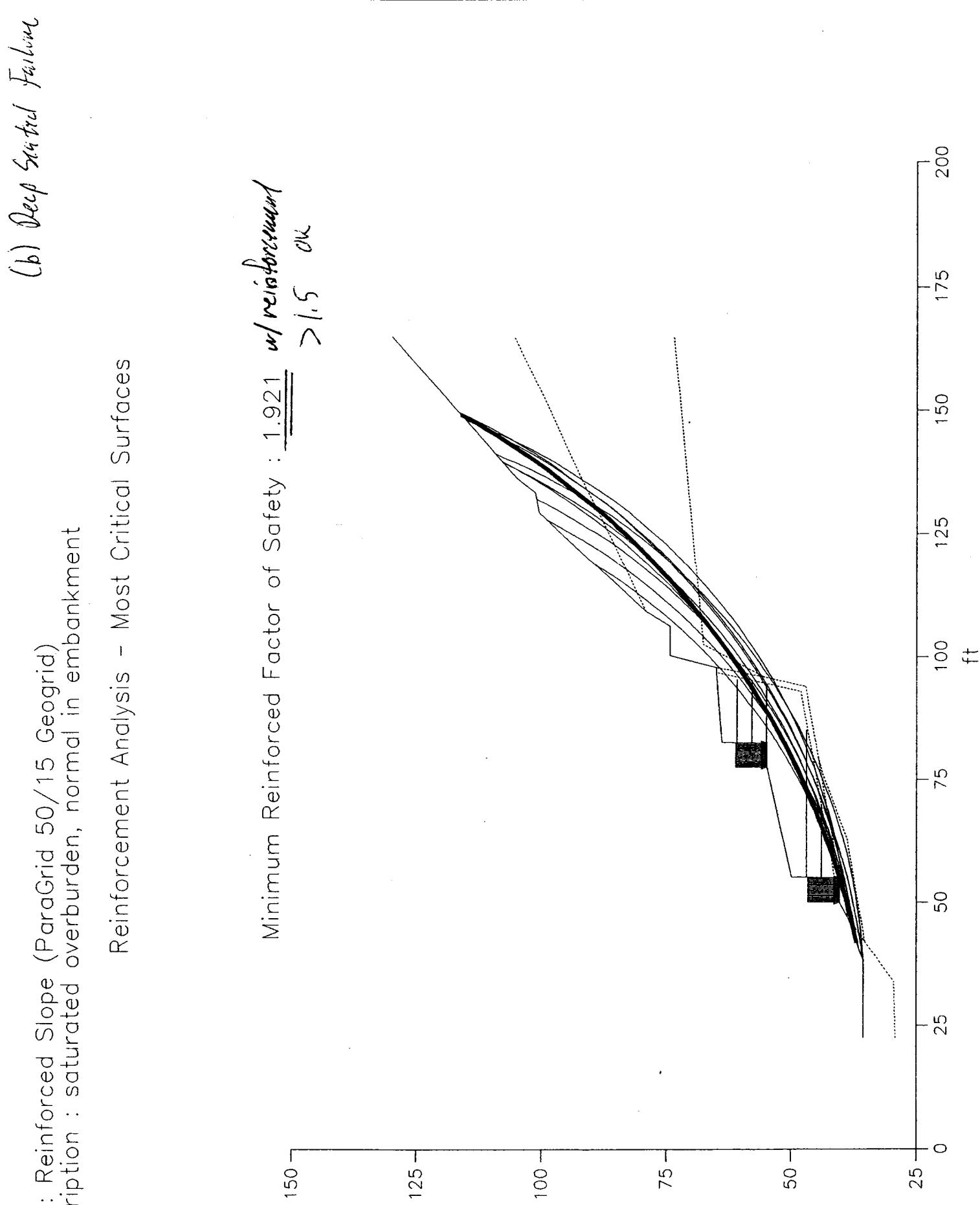
(a) Deep Seated Failure

Minimum Factor of Safety : 1.832 without reinforcement  
 $\Rightarrow 1.5 \text{ OK}$



Title : Reinforced Slope (ParaGrid 50/15 Geogrid)  
Description : saturated overburden, normal in embankment

Reinforcement Analysis - Most Critical Surfaces

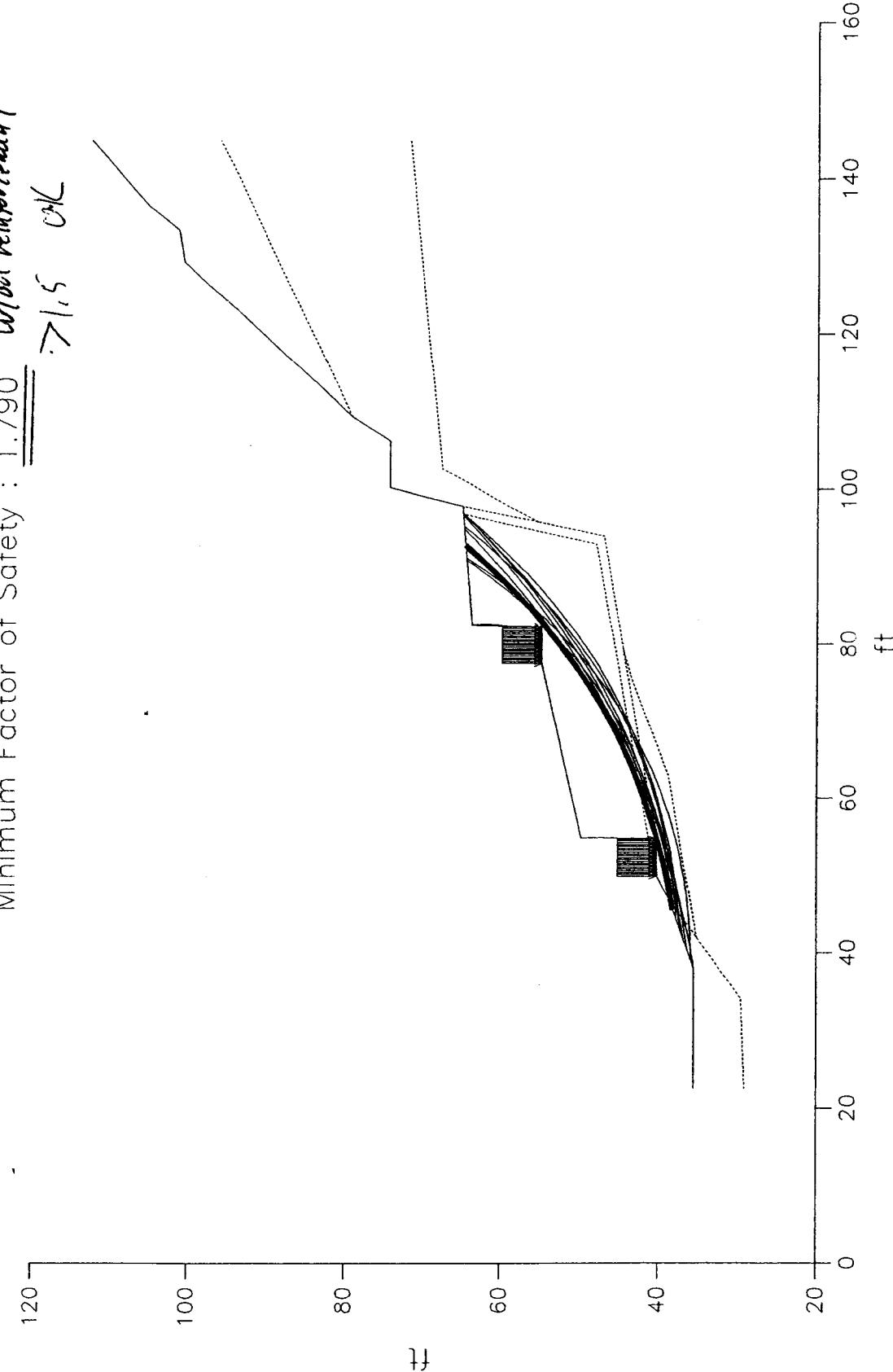


Title : Reinforced Slope (ParaGrid 50/15 Geogrid)  
Description : saturated overburden, normal in embankment

Bishop Circular Surfaces - Most Critical Surfaces

(c) Buckfill failure

Minimum Factor of Safety : 1.790 without reinforcement  
 $\Rightarrow 1.5 \text{ ok}$

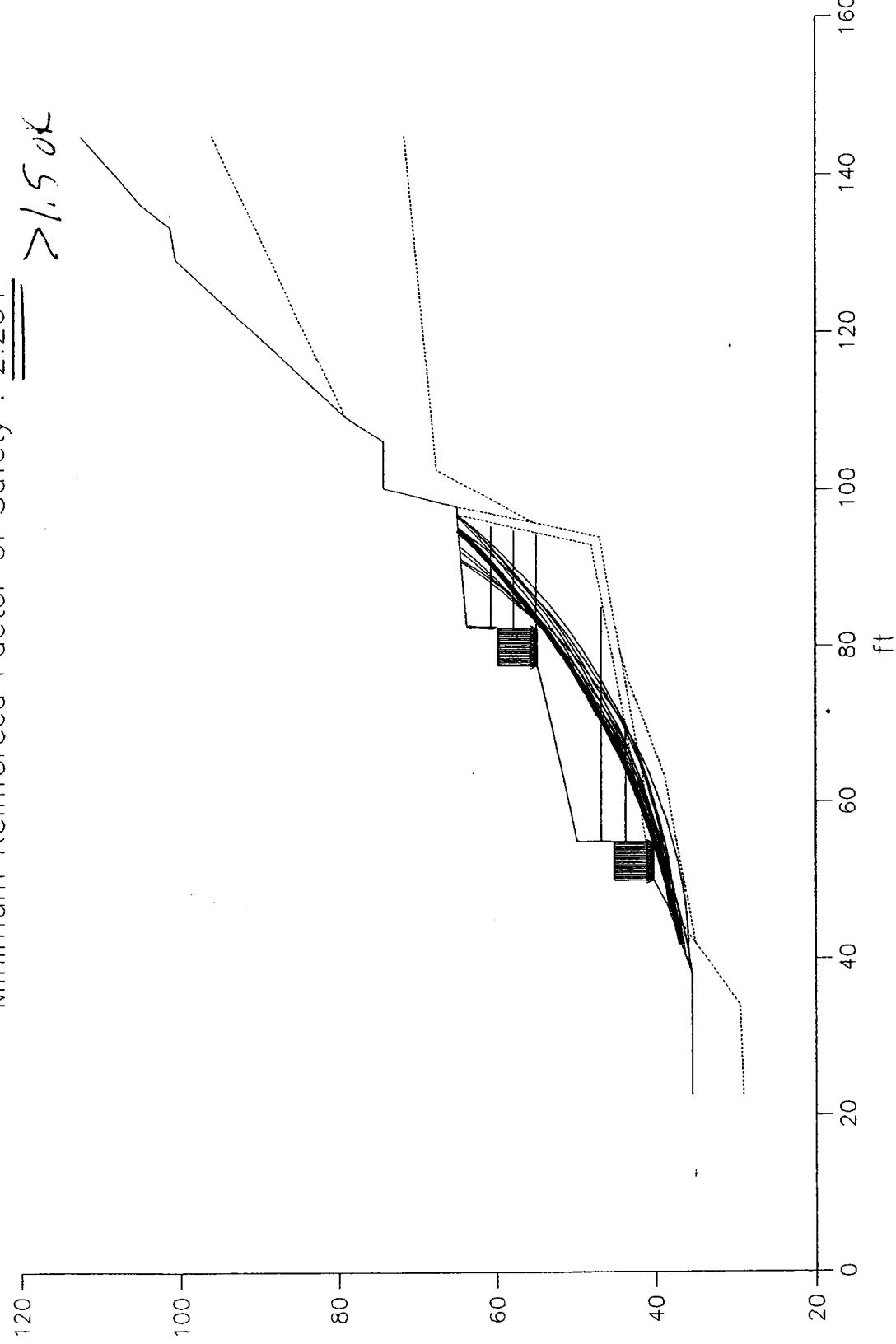


Title : Reinforced Slope (ParaGrid 50/15 Geogrid)  
Description : saturated overburden, normal in embankment

### Reinforcement Analysis - Most Critical Surfaces

(d) Backfill Failure

Minimum Reinforced Factor of Safety : 2.201 w/ reinforcement  
 $\geq 1.5 \text{ ok}$



## Computation Sheet

BY PMK DATE 7/01 SUBJECT Sedimentation Analysis SHEET 1 OF 6  
CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_ Sunshine/Hematite Claims Project – Test Pit JOB NO. \_\_\_\_\_

1. Compare sediment delivery characteristics of partially vegetated hillside draw slope versus gabion stabilized terraces. If required, evaluate additional control practices to mitigate excess sedimentation.
2. Methodology (Barfield, B.J., Warner, R.C. & Haan, C.T. (1981) *Applied Hydrology and Sedimentology for Disturbed Areas*, Oklahoma Technical Press, Stillwater).

Compare erosion loss using Universal Soil Loss Equation

$$A = \text{sediment (in tons/acre)} = R * K * LS * CP$$

where:  
R = Rainfall & Erosivity Index Factor  
K = Soil Erodibility Factor  
LS = Slope Angle and Length Factor  
CP = Control Practice Factor

3. Determine Erosion Loss Factors for both existing and reclaimed slopes.

- A. R = Rainfall Factor (note: rainfall factor will remain constant for existing and reclaimed slope)

$$= \frac{EI_{30}}{100} = 16.55 \cdot P_{2.5}^{2.2}$$

(Barfield, et al., pg 312-316)

$$P_{2.5} = 0.88$$

(Moon Lake region, fig. 5.4, pg. 315, attached)

$$= \frac{EI_{30}}{100} = 16.55 \cdot 0.88^{2.2} = 12.5$$

- B. Soil Erodibility Factor (value to be obtained by nomograph, attached)

- Surface of the existing partially vegetated hillside draw slope: approximately 50% of the area is barren talus slope with little to no vegetation – moderate to coarse grained cobbles and gravels in a clay matrix – well armored. The remainder of the area is a vegetated draw with small piñon and brush no taller than 3 feet above the surface. Same soils dominate this location, with a thin veneer of organic topsoil with less cobbles (moderate to fine grained). Moderate to rapid percolation anticipated. Near-surface soils have the following approximate gradation distribution:

Cobble & gravel = 61% (by weight)

Sands = 15%

Silts & clays = 20%

Organics (in vegetated areas) = 4%

From nomograph, K = 0.09 for the existing slope

## Computation Sheet

BY PMK DATE 7/01 SUBJECT Sedimentation Analysis SHEET 2 OF 6  
 CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_ Sunshine/Hematite Claims Project – Test Pit JOB NO. \_\_\_\_\_

- Surface of the reclaimed hillside will be terraced and contain more fine-grained soils (similar to soils within vegetated portions of existing draw) within the upper 12-24 inches to promote vegetation growth. Because of the higher clay content, disturbance and compaction, percolation is anticipated to be slow to moderate. Near surface soils are anticipated to have the following approximate gradation distribution:

Cobble & gravel = 49% (by weight)

Sands = 20%

Silts & clays = 30%

Organics (in vegetated areas) = 1%

From nomograph,  $K = 0.15$  for the reclaimed terraces and upper cut slope. The erodibility factor for the low permeability rock cut bench and face would be 0.10 (source of erodibility factor nomograph: Barfield, et al., Fig. 5.13)

### C. Slope-Length Factor

$$LS = \left( \frac{x}{72.6} \right)^m \cdot \frac{430x^2 + 30x + 0.43}{6.613} \quad (\text{Barfield, et al., pg 333})$$

where:  $\lambda$  = slope length

$m = 0.5$  for slopes greater than 5% ( $2.9^\circ$  slope angle)

$0.3$  for slopes less than 3% ( $1.7^\circ$  slope angle)

$x = \sin \theta$ ,  $\theta$  = slope angle

- Surface of the existing slope behind the existing gabion wall: 56% partially vegetated hillside draw; 44% barren/disturbed talus slope with little to no vegetation. Evaluate each area separately.

Area	Average slope, $\theta$	$\sin \theta$	Slope length, (ft)
partially vegetated slope	$27^\circ$	0.434	50
barren/disturbed slope	$9^\circ$	0.156	23

$$LS_{pv} = \left( \frac{50}{72.6} \right)^{0.5} \cdot \frac{430 \cdot (0.434)^2 + 30 \cdot (0.434) + 0.43}{6.613} = 11.85$$

$$LS_{bd} = \left( \frac{23}{72.6} \right)^{0.5} \cdot \frac{430 \cdot (0.156)^2 + 30 \cdot (0.156) + 0.43}{6.613} = 1.33$$

- Reclaimed gabion terraces have variable slopes and slope length shown as follows:

Area	Average slope, $\theta$	$\sin \theta$	Slope length, (ft)
lower terrace	$11.3^\circ$	0.196	23
upper terrace	$4.8^\circ$	0.083	15
rock cut face	$78.7^\circ$	0.981	10
bench	$30.5^\circ$	0.508	15
upper cutback slopes	$45^\circ$	1.000	12

## Computation Sheet

BY PMK DATE 7/01 SUBJECT Sedimentation Analysis SHEET 3 OF 6

CHKD. BY  DATE  Sunshine/Hematite Claims Project – Test Pit  JOB NO.

$$LS_{hi} = \left( \frac{23}{72.6} \right)^{0.5} \cdot 430 \cdot (0.196)^2 + 30 \cdot (0.196) + 0.43 = 1.94$$

$$LS_{ul} = \left( \frac{15}{72.6} \right)^{0.5} \cdot 430 \cdot (0.083)^2 + 30 \cdot (0.083) + 0.43 = 0.40$$

$$LS_{rf} = \left( \frac{10}{72.6} \right)^{0.5} \cdot 430 \cdot (0.981)^2 + 30 \cdot (0.981) + 0.43 = 24.90$$

$$LS_b = \left( \frac{15}{72.6} \right)^{0.5} \cdot 430 \cdot (0.508)^2 + 30 \cdot (0.508) + 0.43 = 8.70$$

$$LS_{ucl} = \left( \frac{12}{72.6} \right)^{0.5} \cdot 430 \cdot (1)^2 + 30 \cdot (1) + 0.43 = 28.31$$

### D: Control Practice Factor

(per Barfield, et al. recommendations on Pg 337, surface mining operations should focus on the control factor in exclusion of the cover portion of the factor)

- Surface of the existing slope behind the existing gabion wall: 56% partially vegetated hillside draw; 44% barren/disturbed talus slope with little to no vegetation. Evaluate each area separately.

Area	Control Factor	Source (Barfield, et al.)
partially vegetated slope	0.05 <sup>(1)</sup>	Table 5.A.3
barren/disturbed slope	0.54 <sup>(2)</sup> – 0.30 <sup>(3,4)</sup>	Table 5.A.1, 5.A.2

(1) Little decay residue, under 50% tall brush canopy, under 50% ground cover

(2) Bare soil, seeded, after 6 months

(3) Fair weed/grass cover, disked, moderate surface roughness, 4 years old

(4) From 5-8 years old reduce by 15%, +8 years old 30%

- Reclaimed gabion terraces will have variable control practice conditions as follows:

Area	Control Factor	Source (Barfield, et al.)	% Area <sup>(5)</sup>
lower terrace	0.64 <sup>(1,6)</sup> – 0.85 <sup>(2,6)</sup>	Table 5.A.1, 5.A.2	42
upper terrace			21
rock cut face	0.043 <sup>(3)</sup>	Table 5.A.3	2
bench			4
upper cutback slopes	0.90 <sup>(4,6)</sup> – 0.94 <sup>(5,6)</sup>	Table 5.A.1, 5.A.2	17

(1) Bare soil, seeded, fresh

(2) Poor cover, no weed cover, disked/raked/bedded, minor depressions

(3) +80% rock cover, no canopy, no residue

(4) Bare soil, raked across by equipment

(5) Poor cover, no weed cover, disked/raked/bedded

(6) From 1-4 years after placement reduce by 30%, 5-8 years 40%, +8 years 50%

(7) 14% of total area is covered by gabion walls

CP factor assumes that return of vegetation will take over 10 years (per FS comments)

# Computation Sheet

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## 4. Calculate Erosion Loss for existing and reclaimed slopes

- Existing Slope:

Year	Location	R	K	LS	CP	% Area	A (t/ac)
1	partial vegetation	12.5	0.09	11.85	0.05	0.56	
	barren/disturbed			1.33	0.42	0.44	0.65
2-5	partial vegetation	12.5	0.09	11.85	0.05	0.56	
	barren/disturbed			1.33	0.38	0.44	0.62
6-10	partial vegetation	12.5	0.09	11.85	0.05	0.56	
	barren/disturbed			1.33	0.30	0.44	0.57

- Reclaimed Slope:

Year	Location	R	K	LS	CP	% Area	A (t/ac)
	lower terrace	12.5	0.15	1.94	0.75	0.42	
	upper terrace		0.15	0.40	0.75	0.21	
1	rock cut face	12.5	0.1	24.9	0.043	0.02	
	bench		0.1	8.7	0.043	0.04	
	upper cutback slopes	12.5	0.15	28.31	0.92	0.17	
	lower terrace		0.15	1.94	0.53	0.42	
	upper terrace	12.5	0.15	0.40	0.53	0.21	
	rock cut face		0.1	24.9	0.043	0.02	
	bench	12.5	0.1	8.7	0.043	0.04	
	upper cutback slopes		0.15	28.31	0.64	0.17	
	lower terrace	12.5	0.15	1.94	0.45	0.42	
	upper terrace		0.15	0.40	0.45	0.21	
5-8	rock cut face	12.5	0.1	24.9	0.043	0.02	
	bench		0.1	8.7	0.043	0.04	
	upper cutback slopes	12.5	0.15	28.31	0.55	0.17	
	lower terrace		0.15	1.94	0.38	0.42	
	upper terrace	12.5	0.15	0.40	0.38	0.21	
	rock cut face		0.1	24.9	0.043	0.02	
	bench	12.5	0.1	8.7	0.043	0.04	
	upper cutback slopes		0.15	28.31	0.46	0.17	

Analysis shows that 85% of the sediment derives from upper cutback slopes and 12% derives from lower terrace. Evaluate use of the following control practices for these sediment sources (CP factors from Barfield, et al., Fig. 5.16b and Table 5.8):

- Straw @ 1 ton per acre CP = 0.20
- Excelsior blanket CP = 0.07
- Wood fiber slurry @ ½ ton per acre CP = 0.05

# Computation Sheet

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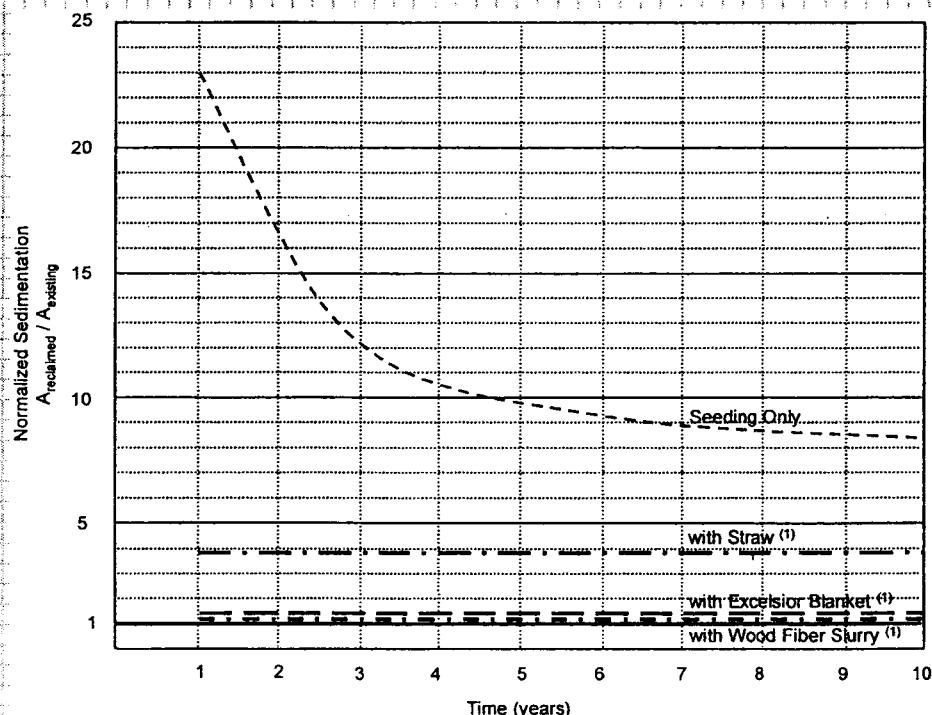
Results of supplemental control practices on sedimentation are shown below:

Treatment <sup>(1)</sup>	Year	A (t/ac)
Straw	1	2.27
	2-4	2.24
	5-8	2.23
	9-10	2.22
	1	0.94
Excelsior Blanket	2-4	0.87
	5-8	0.85
	9-10	0.84
	1	0.69
	2-4	0.66
Wood Fiber Slurry	5-8	0.64
	9-10	0.63
	1	0.63

<sup>(1)</sup> Treatment on lower terrace and upper cutback slopes only

## 5 Compare sedimentation rates for existing and reclaimed slopes

Normalize all rates with existing slope as the baseline – show each control practice



<sup>(1)</sup> Treatment on lower terrace and upper cutback slopes only

## Computation Sheet

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### 5. Conclusions

- Test pit reclamation with only seeding will result in significant soil loss above existing values.
- Primary locations of soil loss are the cutback slopes above the test pit (approximately 21% of the total disturbed area) and the lower terrace above the existing gabion wall (approximately 42% of the total disturbed area).
- Placement of an Excelsior blanket or wood fiber slurry on cutback slope and lower terrace will reduce sedimentation to match existing slope rates.

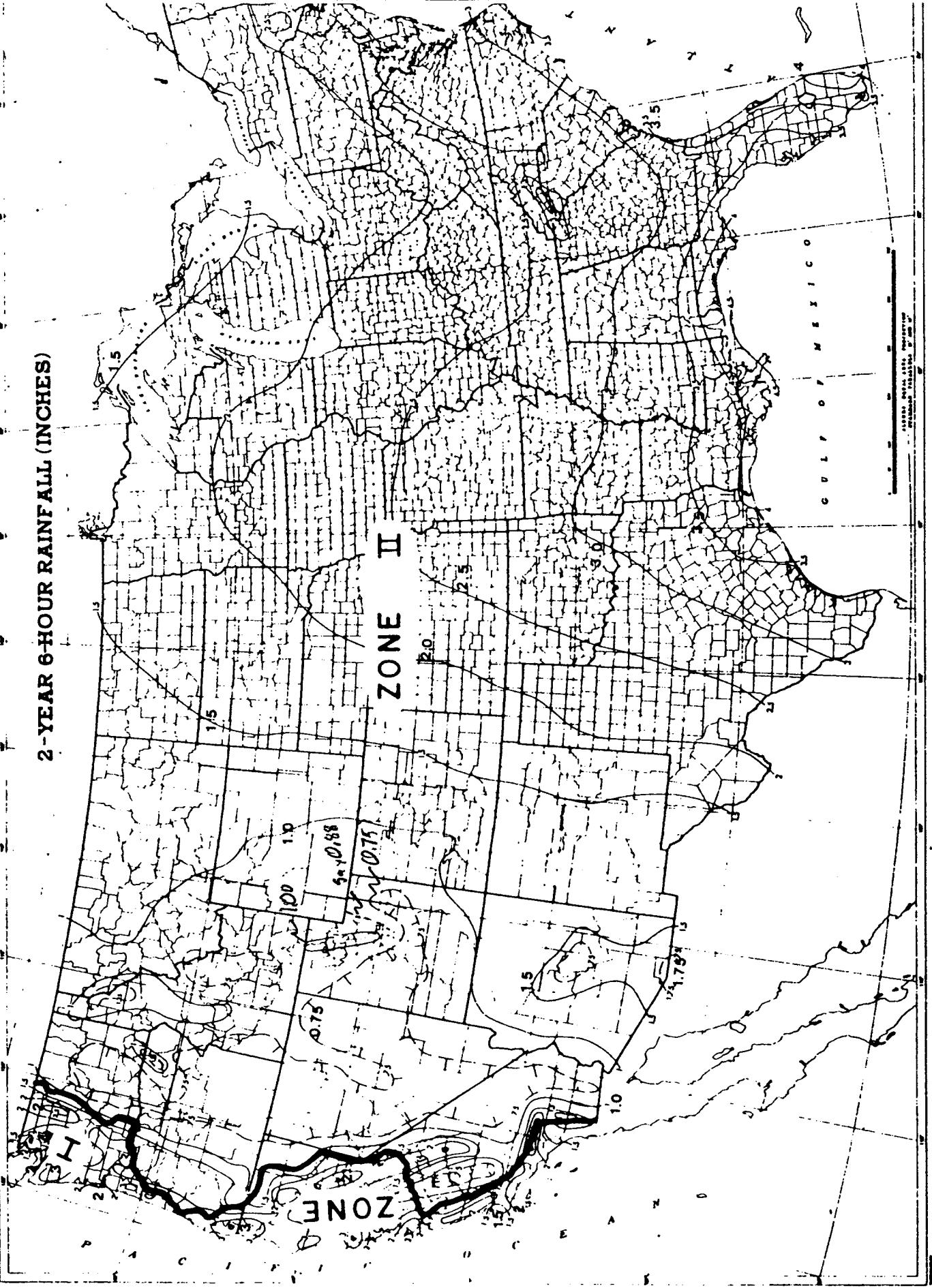
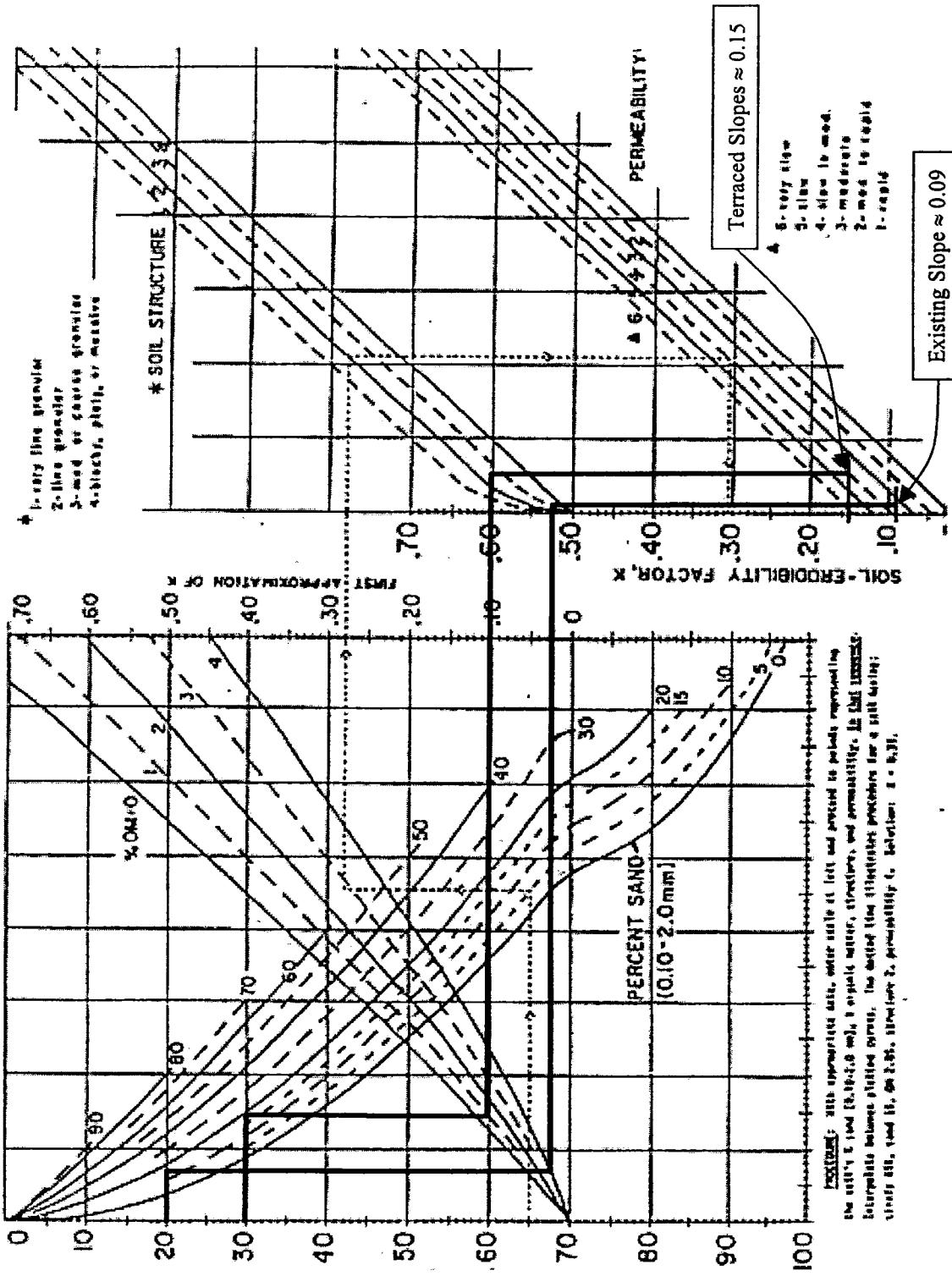
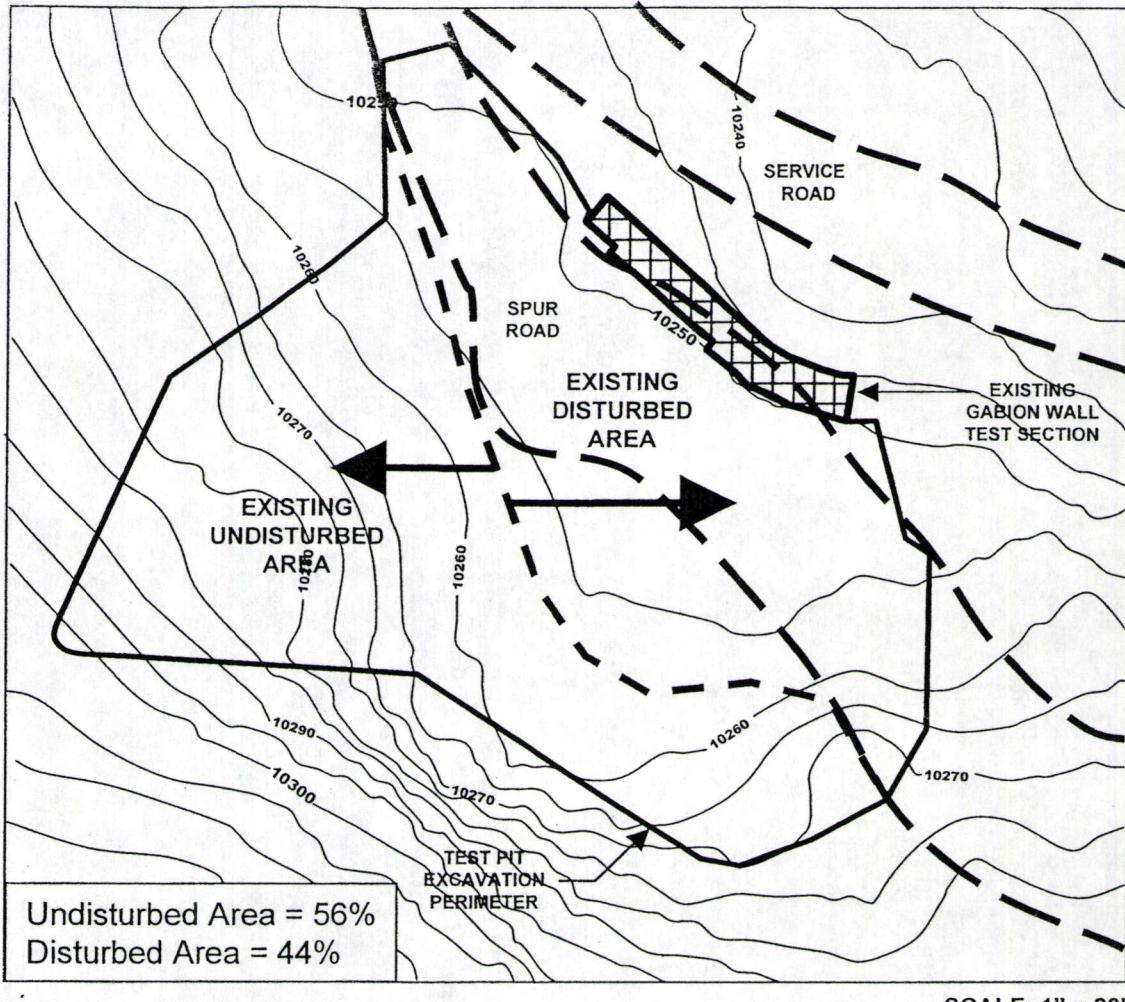
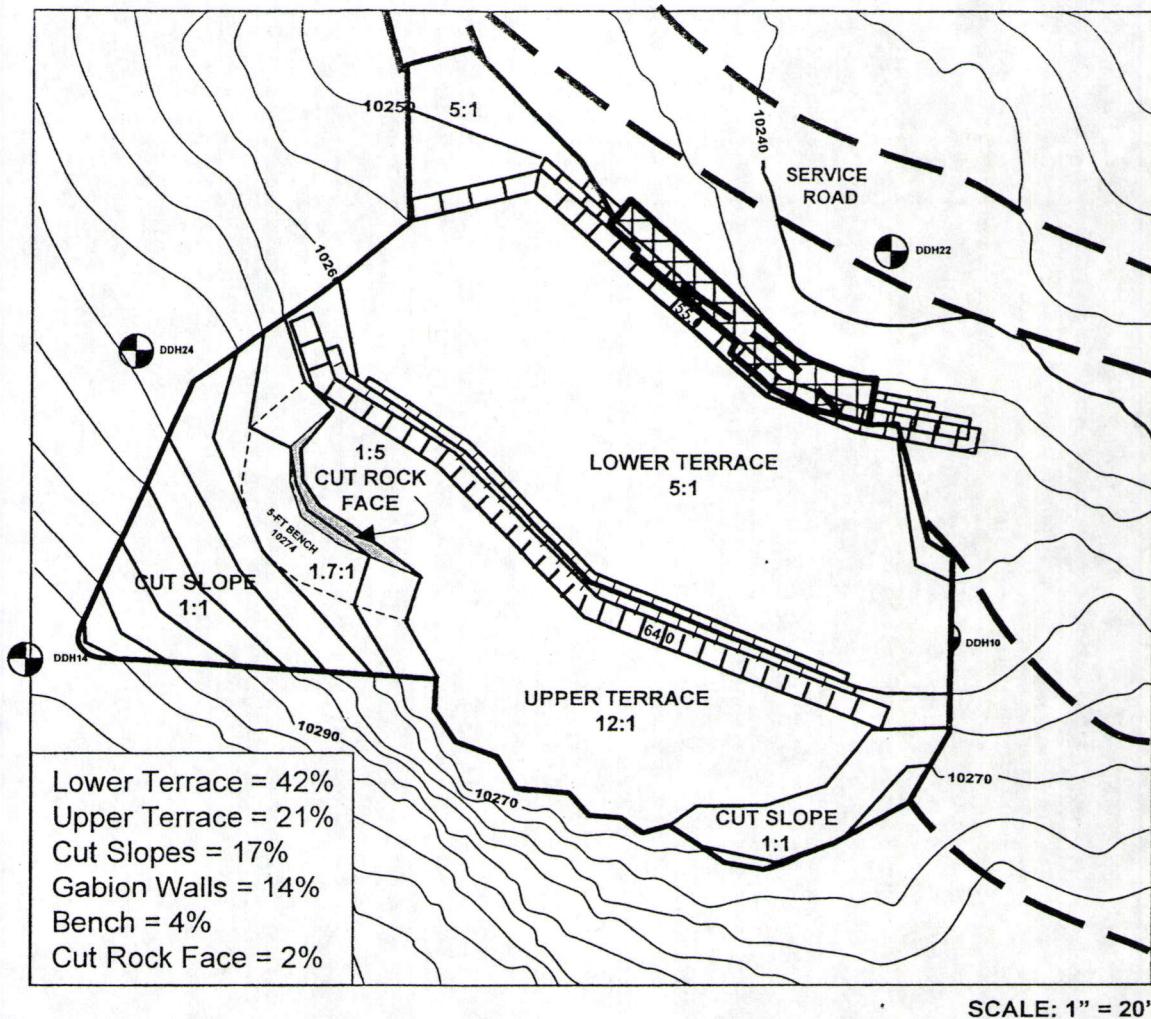


Figure 5.4. Depths of the 2-year, 6-hour rainfall, inches. (Hotes et al., 1973)





TEST PIT AREA – REVISED EXCAVATION LIMITS



TEST PIT AREA – REVISED RECLAMATION LIMITS

Appendix 5A

Table S A 1 Typical C Factor Values Reported in the Literature \*

Condition	C factor
1. Bare soil conditions	
freshly disked to 6-8 inches	1.00
after one rain	0.89
loose to 12 inches smooth	0.90
loose to 12 inches rough	0.80
compacted root raked	1.20
compacted bulldozer scraped across slope	1.20
same except root raked across	0.90
rough irregular tracked all directions	0.90
seed and fertilize, fresh, unprepared seedbed	0.64
same after six months	0.54
seed, fertilize and 1/2 months chemical	0.38
not tilled algae crusted	0.01
tilled algae crusted	0.02
D undisturbed except scraped	0.66 - 1.30
D scarified only	0.76 - 1.31
G sawdust 2 inches deep, disked in	0.61
2. Asphalt emulsion	
1210 gallons/acre	0.01 - 0.019
605 gallons/acre	0.14 - 0.57
302 gallons/acre	0.28 - 0.60
3. Dust binder	
605 gallons/acre	1.05
1210 gallons/acre	0.29 - 0.78
4. Other chemicals	
1000 lb fiber glass roving with 60-150 gallons/acre	0.01 - 0.05
Aquatain	0.68
Aerospray 70, 10 percent cover	0.94
Curasol AE	0.30 - 0.48
PVA	0.71 - 0.90
Terra-Tack	0.66
wood fiber slurry, 1400 lb/acre fresh	0.01 - 0.02
wood fiber slurry, 3500 lb/acre fresh	0.10
5. Seedings <sup>1</sup>	
temporary, 0 to 60 days <sup>2</sup>	0.40
temporary, after 60 days	0.05
permanent, 2 to 12 months	0.05
6. Brush	0.35

If  $d = \frac{1}{2}$ , then  $\alpha = \frac{1}{2}$ . In this case, the condition  $\alpha < d$  is violated.

If dry weather occurs at planting and emergence is a

0-60 days to a period when rainfall normally occurs.

National Cooperative Highway Research Program, 1976.

Table 5.A.2. C Factors for Mechanically Prepared Woodland Sites.<sup>4</sup>

Table 5.A.3. C Factors for Permanent Pasture, Rangeland, Idle Land, and Grazed Woodland.<sup>1</sup>

Vegetal Canopy	Cover that Contacts the Surface							
	Type and Height of Raised Canopy <sup>2</sup> .	Canopy Cover <sup>3</sup> .	Type <sup>4</sup> .	Percent Ground Cover				
%	%		0	20	40	60	80	95-100
No appreciable canopy		G W	.45 .45	.20 .24	.10 .15	.042 .090	.013 .043	.003 .011
Canopy of tall weeds or short brush (0.5 m fall ht.)	25 50 75	G W G W G W	.36 .36 .26 .26 .17 .17	.17 .20 .13 .16 .10 .12	.09 .07 .075 .11 .06 	.038 .082 .035 .012 .031 .067	.012 .041 .039 .039 .011 .038	.003 .011 .003 .011 .003 .011
Appreciable brush or bushes (2 m fall ht.)	25 50 75	G W G W G W	.40 .40 .34 .34 .28 .28	.18 .22 .16 .19 .14 .17	.09 .14 .085 .13 .081 .12	.040 .085 .038 .012 .041 .036	.013 .042 .012 .011 .011 .012	.003 .011 .003 .011 .003 .011
Trees but no appreciable low brush (4 m fall ht.)	25 50 75	G W G W G W	.42 .42 .39 .39 .36 .36	.19 .23 .18 .21 .17 .20	.10 .14 .09 .14 .09 .13	.041 .087 .040 .085 .039 .083	.013 .042 .013 .042 .012 .041	.003 .011 .003 .011 .003 .011

Table 5.A.4. C Factors for Undisturbed Woodland.<sup>4</sup>

Effective Canopy <sup>1</sup> . % of Area	C <sup>3</sup> . Factor	Forest Litter <sup>2</sup> . % of Area
100-75	.0001-.001	100-90
70-40	.002-.004	85-75
35-20	.003-.009	70-40

1. When effective canopy is less than 20%, the area will be considered as grassland or idle land for estimating soil loss. Where woodlands are being harvested or grazed, use Table 5.6.
2. Forest litter is assumed to be at least two inches deep over the percent ground surface area covered.
3. The range in C values is due in part to the range in the percent area covered. In addition the percent of effective canopy and its height has an effect. Low canopy is effective in reducing raindrop impact and in lowering the C factor. High canopy, over 1.3 meters, is not effective in reducing raindrop impact and will have no effect on the C value.
4. Soil Conservation Service (1977).

1. All values shown assume: (1) random distribution of mulch or vegetation, and (2) mulch of appreciable depth where it exists. Idle land refers to land with undisturbed profiles for at least a period of three consecutive years. Also to be used for burned forest land and forest land that has been harvested less than three years ago.
2. Average fall height of waterdrops from canopy to soil surface: m = meters.
3. Portion of total area surface that would be hidden from view by canopy in a vertical projection (a bird's-eye view).

4. G: Cover at surface is grass, grasslike plants, decaying compacted duff or litter at least 2 inches deep.
- W: Cover at surface is mostly broadleaf herbaceous plants (as weeds with little lateral root network near the surface), and/or undecayed residue.
5. Soil Conservation Service (1977).

*Limitations to Time of Exposure*

When considering limitations to the time that a denuded area is exposed, it is necessary to use a weighted C value for calculating average annual erosion. The C value for each stage of exposure weighted according to the fraction of average annual rainfall received during that stage. An example will serve to illustrate the process.

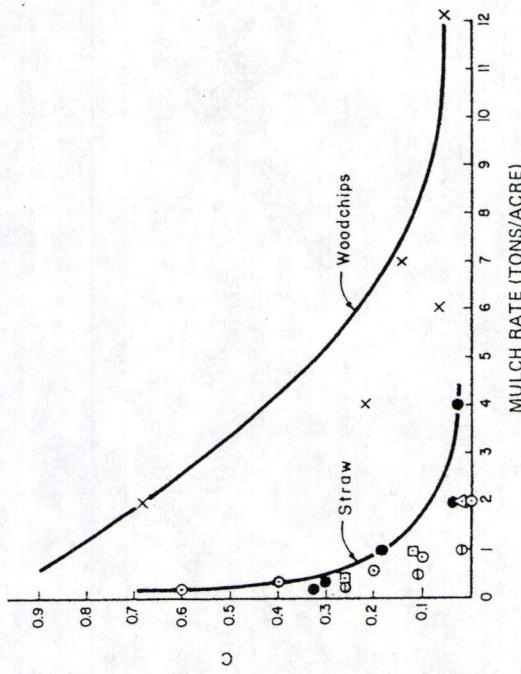


Figure 5.16b. Control factor, C, of surface mulching. (Chen, 1974)

Chemicals are also available for stabilizing the soil surface. C values for selected chemicals are tabulated in Table 5.8. A more complete listing can be found in Table 5.A.1.

Table 5.8 Selected C Values reported in the literature. A comprehensive list is given in Appendix 5A.

Condition	C factor	Time Period	Activity	Cumulative <sup>1</sup> % of Annual R	% of Average Annual R during Period	Weighted C (C <sub>w</sub> )	Weighted C (C <sub>w</sub> ) x
(1)	(2)	(3)	(4)	(5)	(6)	(5)	(6)
1. Bare soil conditions							
compacted bulldozer scraped up and down	1.30	1/1 - 4/1	Dense Forest	14	14	.0012.	.0012.
compacted fill	1.24 - 1.71	4/1 - 6/1	Bare Soil	27	13	.453.	.58
2. Asphalt emulsion		6/1 - 8/1	Active Mining	62	35	1.005.	35.0
1.250 gallons/acre	0.02	8/1 - 9/1	Regraded	79	17	.943.	15.5
1.51 gallons/acre	0.65 - 0.70	9/1 - 11/1	Permanent Seeding (1st 60 days)	92	13	.404.	5.4
3. Other chemicals		11/1 - 12/31	Permanent Seeding (remainder of year)	100	8	.054.	.4
Petroset SB	0.40 - 0.66						
wood fiber slurry, 1,000 lb/acre fresh	0.05						
4. Seedings <sup>1</sup>							
permanent, 0 to 60 days <sup>2</sup>	0.40						
permanent, after 12 months	0.01						
5. Excisor blanket with plastic net	0.04 - 0.10						
Total	62.4						

1. Table 5.1. (Geographic Region 20)
  2. Table 5.A.4.
  3. Table 5.A.2.
  4. Table 5.A.1.
  5. Construction activity value = 1.00
1. If plantings are used with mulches, use the minimum C values.
  2. If dry weather occurs at planting and emergence is a problem, extend the 0-12 month period by one year.

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Mine Permit Number SO130002 Mine Name SunShine / Hematite  
Operator Ullintah Mountain Copper Date 12-03-2001  
TO \_\_\_\_\_ FROM US Forest Service

CONFIDENTIAL  BOND CLOSURE  LARGE MAPS  EXPANDABLE  
 MULTIPUL DOCUMENT TRACKING SHEET  NEW APPROVED NOI  
 AMENDMENT  OTHER

Description	YEAR-Record Number
-------------	--------------------

NOI  Incoming  Outgoing  Internal  Superceded

Plan of Operation for mining Activities  
On National Forest System Lands

NOI  Incoming  Outgoing  Internal  Superceded

NOI  Incoming  Outgoing  Internal  Superceded

NOI  Incoming  Outgoing  Internal  Superceded

TEXT/ 81/2 X 11 MAP PAGES  11 X 17 MAPS  LARGE MAP

COMMENTS: \_\_\_\_\_

CC: \_\_\_\_\_